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# AN OUTPUT STUDY OF USERS AND NON-USERS OF TOBACCO IN A STRENUOUS PHYSICAL OCCUPATION*

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## INTRODUCTION

IN a previous paper, the first of a series of articles dealing with the general problem of the significance of the use of tobacco in industry, some observations were reported on the effects of smoking on efficiency in a strenuous *mental* occupation (1). The present paper is concerned with the second phase of the general topic: namely, the relation of the use of tobacco to efficiency in a strenuous *physical* occupation. In this investigation, as in our previous report, we have adopted output as the criterion of efficiency (2).

An output study requires a routine occupation in which the same process is repeated many times during the day and, to be wholly satisfactory, requires also that the number of repetitions be entirely dependent on the speed of the individual worker, unaffected by the rate at which machinery is driven. Obviously tobacco effects, if any exist, would be most likely to appear in a very strenuous occupation. The occupation to be selected for study should, therefore, be routine, physically strenuous, and dependent on individual initiative.

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After some search we decided on bottle making as meeting these conditions satisfactorily. Permission was obtained to make an output study in a large glass bottle manufacturing plant, which operates thirty-five bottle-making machines and employs 500 persons. We wish to take this opportunity of thanking the superintendent and the personnel of the factory for their courteous treatment of us during the three weeks of the investigation.

## PROCESS

The process of glass blowing may be briefly described as follows: The old method of blowing glass bottles by mouth has been largely abandoned except for small special orders, and this highly skilled work is now done by machinery manipulated by a skilled "gatherer" and "cutter" and inexperienced helpers. In some machines the whole process is carried out automatically and only an unskilled attendant is required. In the majority of machines, however — and it was with this type of machine that our work was concerned — the gatherer regulates the speed of the machine by his own motions. The

machines are located at one end of an oval tank containing the fused glass, which is kept at a temperature of 2650°F. The wall of the tank is perforated with working holes at intervals of about 12 feet, and foot benches of appropriate height for the gatherers are situated at each hole. The machine is located at the left of the foot bench and consists usually of two revolving tables, the first of which bears a number of iron blanks in which the neck of the bottle and a depression in the center can be formed. The second revolving table carries molds in which the final form can be given to the bottle. The operation is as follows:

The gatherer stands on the foot bench at the working hole with a "punty" in hand. This is an instrument 43 inches long, consisting of an iron rod with a wooden handle at one end and a clay ball on which the glass is collected, at the other end. The gatherer has his back toward the machine and holds the punty handle with both hands, allowing the clay ball to touch the surface of the fused glass. The iron rod of the punty rests on an iron support ("dog leg") at the edge of the working hole, while the gatherer revolves the punty until sufficient glass adheres to form a "gob" of the size required to make the proper weight bottle. The gatherer then turns to the left and, suspending the gob over the mouth of the blank, allows the glass to drip off. When the proper amount has fallen, the cutter clips the stream of glass with a pair of shears. The gatherer then turns back to the hole and again inserts the punty. The motions of the gatherer are exceedingly rapid and accurate and as many as twenty-six 2-ounce gobs may be gathered in one minute.

The cutter sits on a stool at the edge of the foot bench and clips off the stream of glass from the punty as it falls into the blank; he then pulls a lever which brings down a plunger into the center of the blank, shaping the neck and making a depression in the glass, revolves the table so that the bottle is partially blown automatically, greases (with a graphite covered plunger) another blank, and is ready to receive the next gob of glass.

The "take-out boy" (unskilled) is seated on a stool opposite the cutter; he opens the blank, removes the half-blown bottle by means of pincers, and drops it into a mold on the mold table. The second helper is seated at the mold table which he revolves so that the bottle is fully blown by an automatic blower, and passes under a torch to smooth the mouth. He then opens the mold, places the finished bottle on a table, and closes the mold.

The "carrying-in boy," by means of a "carrying stick" (an asbestos-covered, long handled implement) transfers the bottles, a row at a time, into the "tempering lehr," the floor of which moves the bottles very slowly through an oven of decreasing temperature until the bottles are taken out cool at the other end, where they are packed.

In the Lynch machine, this whole process is carried out by a gatherer and a carrying-in boy, the gatherer regulating the speed of the machine just as he does in the type described above. In the Lynch type in the process of dripping the gob into the blank, the gatherer touches with his punty a lever which puts the whole machine into motion. Thus, for each gob gathered the machine makes one complete revolution.

### Operatives

The helpers, carrying-in boys, and take-out boys are all unskilled, unorganized laborers and, though called "boys," are usually over 20, the carrying-in being done by men of 40 or over, who are not quick enough for the other work. During the war many women were taken on as helpers, and some white and some colored women have continued in this work. The

labor turnover among the unskilled employees is very high.

The gatherers alternate every half hour in the processes of cutting and gathering. On the Lynch machine three gatherers operate two machines; one gatherer is assigned to each machine on which he works 40 minutes, and then rests and oils the machine for 20 minutes; the third man works 20 minutes on each machine and rests and oils the two machines for 20 minutes. The gatherers are the only skilled workers on the machines and have inherited the pride of the craft of glass blowing and are very proud of their dexterity and speed. Indeed, a speedy man is usually the center of attraction for all who happen not to be at work at the time. This pride buoys the men up and increases their output, as will be shown in another paper. The turnover for gatherers is very slight, and it is not rare to find men who have worked over five years in the same plant.

The average age of the eighty-five gatherers studied was 36 years, of which an average of twenty years had been spent in the glass industry. A study of the correlation of age and output gave negative results as did also a study of correlation of overweight and underweight and output. The men averaged 4 pounds overweight, on the basis of the biometric tables of the Provident Life & Trust Co., which seems to indicate that the work is not too strenuous. The men are unionized and work under definite regulations as to hours' and weeks' work. The shifts are from 7 A.M. to 3 P.M., 3 P.M. to 11 P.M., and 11 P.M. to 7 A.M., and the men work for a week on each shift. The plant runs from Monday 7 A.M. to Saturday 12 M. Two weeks' vacation (without pay) between June 15 and September 15 must be taken. Apprenticeship is for three consecutive years. A benefit association is maintained by the Glass Blowers' Association of the United States and Canada. The gatherers are largely of native stock, with little schooling, as the average length of experience shows, and are, on the whole, a very steady, clean-lived group of men. Many expressed the belief that their work was so hazardous and hard that dissipation could not be indulged in without great risk to their health and injury to their efficiency. The men earn from $8 to $10 a day, working on a piece-work basis except when the machines break down, and then they are paid by the hour. The men claim that they can estimate their speed closely enough to calculate their output for the day, but in some cases the carrying-in boy scores each load of bottles he places in the tempering lehr.

## Method

The output records were obtained by passing from one machine to another each half hour and counting the number of gobs of glass gathered by each man in a period of from one to five minutes. The data, therefore, show *output rate* only and are not to be construed as actual output. It was found that actual output is not a dependable criterion of the working capacity of the individual, as in this trade machine breakdown and minor delays, such as result from impurities adhering to the punty-head, are a constant and unaccountable factor entirely independent of the workers' efficiency. It is obvious, however, that output would, in general, correspond to differences in rate of gathering between individuals.

The counting was done by means of a tally register and the timing by means of a stop-watch. The records were kept on a separate card for each man together with the weight of the bottle made and data obtained by a personal interview as to age, height, weight, marital status, years' experience, and smoking and chewing habits. All counts were made at times when the machinery was working without trouble,

and in no case was a count made when any accidental obstruction to the full speed of the worker was present. The gathering had an extremely uniform rate for each individual, and it was found that one minute was a long enough period in which to obtain a count characteristic of the operator. The investigation was carried on for about three weeks and 1,569 hourly counts were made — *i.e.*, an average of 20.3 hourly counts per man.

TABLE 1. — NUMBER OF MEN IN EACH HABIT GROUP

| | |
|---|---|
| Number of men included in habit groups | 76 |
| Non-users of tobacco | 6 |
| Non-smokers | 13 |
| Smokers | 63 |
| Chewers | 22 |
| Light smokers | 23 |
| Heavy smokers | 40 |
| Non-smokers who chew | 7 |
| Light smokers who chew | 8 |
| Heavy smokers who chew | 7 |
| Light smokers who do not chew | 15 |
| Heavy smokers who do not chew | 33 |
| Non-chewers | 54 |
| Non-chewers who smoke | 48 |

## Habits

The smoking or chewing habits of the men were obtained by questioning them directly and by observation and indirect conversation. They appeared to be honest and straightforward in their answers and were all on the best of terms with the investigator. The following arbitrary classification seemed logical, on the basis that about the same amount of tobacco is involved in each case.

Persons who smoked more than ten cigarettes per day, or more than one cigar per day, or more than two pipefuls of tobacço per day were called heavy smokers. Those who smoked less than this were called light smokers, and chewers and non-users of tobacco were classified separately. Table 1 gives the habit groups and the number of men in each class. For lack of adequate data, nine men had to be omitted from the habit groups, leaving seventy-six that were included. Only 8 per cent. of the men do not use tobacco, while 83 per cent. smoke, 29 per cent. chew, and 20 per cent. both smoke and chew.

## Output Rate and Weight of Bottle

In order to determine the efficiency of the men grouped according to their habits, it is necessary to compare their actual output rates. The men were, however, working on bottles of a number of different sizes

TABLE 2. — ACTUAL AVERAGE HOURLY OUTPUT RATE AND PERCENTAGE HOURLY OUTPUT RATE OF ALL WORKERS

| Hour | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–1 | 1–2 | 2–3 |
|---|---|---|---|---|---|---|---|---|
| Actual Output Rate of All Workers (in Number of $8\frac{1}{2}$-Ounce Bottles per Minute) | | | | | | | | |
| *Mean* | *13.6* | *13.59* | *13.53* | *13.75* | *13.53* | *13.45* | *13.59* | *13.44* |
| Standard deviation | 2.32 | 1.98 | 2.02 | 1.98 | 1.77 | 1.99 | 2.01 | 1.88 |
| Probable error of mean ± | 0.186 | 0.141 | 0.146 | 0.141 | 0.155 | 0.149 | 0.15 | 0.14 |
| Coefficient of variability | 17.1 | 14.6 | 14.9 | 14.4 | 13.0 | 14.8 | 14.8 | 14.0 |
| Percentage Hourly Output Rate of All Workers | | | | | | | | |
| *Mean* | *99.2* | *100.5* | *100.04* | *100.3* | *100.44* | *100.01* | *100.08* | *99.3* |
| Standard deviation | 6.0 | 5.4 | 4.2 | 4.16 | 5.4 | 5.2 | 4.48 | 5.3 |
| Probable error of mean ± | 0.48 | 0.386 | 0.30 | 0.29 | 0.46 | 0.39 | 0.35 | 0.39 |
| Coefficient of variability | 6.0 | 6.0 | 4.17 | 4.14 | 5.36 | 5.29 | 4.46 | 5.31 |

and weights. Each machine was assigned a particular weight bottle to be made for a day, or weeks, as the case might be. It requires different lengths of time to gather different weight gobs of glass, but this relationship is not a direct proportion; thus, six and five-tenths 55-ounce gobs can be gathered in a minute, while only twenty-two and five-tenths $1\frac{3}{4}$-ounce gobs can be gathered in the same time. So that the outputs of all the men would be comparable, they were reduced to output for a standard-sized bottle. This was accomplished in the following manner: The average output for each individual who had worked on a certain weight bottle was plotted on co-ordinate paper with the horizontal axis as the number of gobs of glass gathered in a minute, and the vertical axis as weight of the gob in ounces. Having plotted all the individual average outputs for all the different weight bottles that had been handled, the grand average for each weight was also plotted. A curve was then drawn which coincided as closely as possible with the loci of the grand averages. Such a smoothed curve can be drawn with great accuracy according to Bayliss (3). The curve is shown in Figure 1. It was then assumed that the loci of the curve represented the relation existing between the weight of the gob of glass gathered and the number of gobs that could be gathered in one minute. The largest number of individuals and records had been involved in determining the grand average output of $8\frac{1}{2}$-ounce bottles, and the locus of this point seemed to be in good general conformity with the curve as a whole; it was, therefore, selected as a standard.

An example will best serve to illustrate the method used to reduce the output of one individual operator to the standard. Operator 1 gathered twenty-four $1\frac{3}{4}$-ounce gobs of glass in one minute. Referring to Figure 1 we find that twenty-two and five-tenths is the grand average for $1\frac{3}{4}$-ounce bottles, also that thirteen and three-tenths is the grand average for $8\frac{1}{2}$-ounce bottles. Therefore, Operator 1 would be expected to make more than thirteen and three-tenths $8\frac{1}{2}$-ounce bottles in proportion as he had made more than the expected number of $1\frac{3}{4}$-ounce bottles; in other words, the

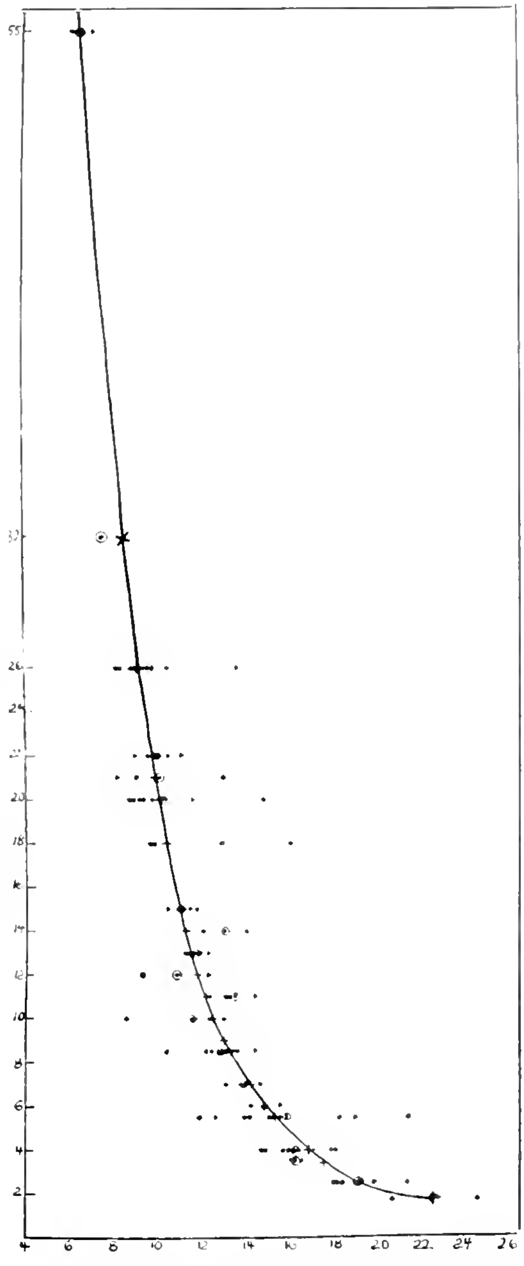


FIG. 1. — Relation of gathering rate to weight of gob. Horizontal axis = number of gobs gathered per minute; vertical axis = weight of gobs in ounces; dots = average gathering rates; circles = grand average gathering rates; crosses = theoretical gathering rates.

TABLE 3.—HOURLY OUTPUT RATE BY HABIT GROUPS

| Hour | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–1 | 1–2 | 2–3 |
|---|---|---|---|---|---|---|---|---|
| **All Non-Smokers** | | | | | | | | |
| *Mean* | *13.27* | *14.12* | *13.89* | *13.96* | *14.0* | *13.75* | *13.96* | *14.04* |
| Standard deviation | 1.25 | 1.44 | 1.45 | 1.74 | 1.36 | 1.87 | 1.69 | 1.82 |
| Probable error of mean ± | 0.34 | 0.27 | 0.27 | 0.32 | 0.29 | 0.364 | 0.316 | 0.34 |
| Coefficient of variability | 9.4 | 10.2 | 10.4 | 12.5 | 9.7 | 13.6 | 12.1 | 13.0 |
| **All Smokers** | | | | | | | | |
| *Mean* | *14.05* | *13.9* | *13.95* | *14.11* | *14.0* | *13.89* | *13.87* | *13.82* |
| Standard deviation | 2.4 | 2.33 | 2.24 | 2.16 | 1.91 | 2.1 | 2.1 | 1.97 |
| Probable error of mean ± | 0.23 | 0.199 | 0.188 | 0.18 | 0.191 | 0.183 | 0.183 | 0.175 |
| Coefficient of variability | 17.1 | 16.6 | 16.0 | 15.2 | 13.6 | 15.1 | 15.1 | 14.2 |
| **All Chewers** | | | | | | | | |
| *Mean* | *13.34* | *13.71* | *13.46* | *13.71* | *14.09* | *13.46* | *13.42* | *13.62* |
| Standard deviation | 1.22 | 1.51 | 1.21 | 1.47 | 1.09 | 1.58 | 1.39 | 1.48 |
| Probable error of mean ± | 0.188 | 0.208 | 0.165 | 0.202 | 0.177 | 0.22 | 0.19 | 0.198 |
| Coefficient of variability | 9.15 | 11.0 | 8.99 | 10.7 | 7.73 | 11.7 | 10.4 | 10.9 |
| **All Non-Users of Tobacco** | | | | | | | | |
| *Mean* | *13.5* | *14.0* | *14.6* | *14.0* | *13.9* | *14.2* | *14.3* | *14.5* |
| Standard deviation | 1.0 | 1.12 | 1.07 | 1.12 | 1.2 | 1.48 | 1.07 | 1.52 |
| Probable error of mean ± | 0.275 | 0.308 | 0.294 | 0.308 | 0.357 | 0.4 | 0.294 | 0.42 |
| Coefficient of variability | 7.4 | 8.0 | 7.3 | 8.0 | 8.6 | 10.4 | 7.45 | 10.4 |
| **All Heavy Smokers** | | | | | | | | |
| *Mean* | *14.67* | *13.92* | *14.17* | *14.4* | *14.24* | *14.29* | *14.44* | *14.05* |
| Standard deviation | 2.68 | 2.52 | 2.32 | 2.2 | 2.02 | 2.23 | 1.36 | 1.9 |
| Probable error of mean ± | 0.310 | 0.266 | 0.236 | 0.224 | 0.24 | 0.232 | 0.145 | 0.203 |
| Coefficient of variability | 18.2 | 18.1 | 16.4 | 15.3 | 14.2 | 15.5 | 10.0 | 13.6 |
| **All Light Smokers** | | | | | | | | |
| *Mean* | *13.44* | *13.54* | *13.22* | *13.5* | *13.5* | *13.06* | *13.31* | *13.44* |
| Standard deviation | 1.69 | 1.29 | 1.29 | 1.41 | 1.36 | 1.55 | 1.99 | 1.99 |
| Probable error of mean ± | 0.288 | 0.19 | 0.214 | 0.212 | 0.256 | 0.244 | 0.308 | 0.308 |
| Coefficient of variability | 12.6 | 9.5 | 10.9 | 10.4 | 10.1 | 11.9 | 14.9 | 14.8 |
| **Heavy Smokers Who Chew** | | | | | | | | |
| *Mean* | *13.5* | *13.12* | *14.06* | *13.83* | *14.07* | *14.0* | *13.5* | *13.83* |
| Standard deviation | 1.29 | 1.22 | 0.68 | 0.9 | 1.06 | 0.7 | 0.7 | 0.48 |
| Probable error of mean ± | 0.35 | 0.29 | 0.152 | 0.2 | 0.269 | 0.167 | 0.167 | 0.104 |
| Coefficient of variability | 12.3 | 9.3 | 4.85 | 6.5 | 7.54 | 5.0 | 5.18 | 3.48 |

TABLE 3.—HOURLY OUTPUT RATE BY HABIT GROUPS—CONTINUED

| Hour | 7–8 | 8–9 | 9–10 | 10–11 | 11–12 | 12–1 | 1–2 | 2–3 |
|---|---|---|---|---|---|---|---|---|
| HEAVY SMOKERS WHO DO NOT CHEW | | | | | | | | |
| *Mean* | *14.67* | *14.26* | *14.27* | *14.56* | *14.29* | *14.39* | *14.53* | *14.11* |
| Standard deviation | 2.92 | 2.68 | 2.62 | 2.44 | 2.32 | 2.46 | 2.30 | 2.20 |
| Probable error of mean ± | 0.386 | 0.325 | 0.306 | 0.28 | 0.312 | 0.292 | 0.27 | 0.27 |
| Coefficient of variability | 19.9 | 18.8 | 18.4 | 16.7 | 16.2 | 17.1 | 16.0 | 15.5 |
| LIGHT SMOKERS WHO CHEW | | | | | | | | |
| *Mean* | *13.5* | *13.8* | *13.0* | *13.37* | *14.1* | *13.38* | *13.17* | *13.39* |
| Standard deviation | 0.17 | 1.42 | 1.25 | 1.16 | 0.65 | 1.62 | 1.56 | 1.67 |
| Probable error of mean ± | 0.047 | 0.518 | 0.296 | 0.276 | 0.195 | 0.363 | 0.35 | 0.373 |
| Coefficient of variability | 1.26 | 10.3 | 9.6 | 8.76 | 4.65 | 12.1 | 11.8 | 12.5 |
| LIGHT SMOKERS WHO DO NOT CHEW | | | | | | | | |
| *Mean* | *14.09* | *13.9* | *13.93* | *13.93* | *13.6* | *14.0* | *14.04* | *13.75* |
| Standard deviation | 1.89 | 0.95 | 1.35 | 1.45 | 1.44 | 1.04 | 1.82 | 1.96 |
| Probable error of mean ± | 0.367 | 0.165 | 0.24 | 0.26 | 0.307 | 0.202 | 0.34 | 0.382 |
| Coefficient of variability | 13.5 | 6.8 | 9.7 | 10.4 | 10.6 | 7.41 | 13.0 | 14.3 |
| CHEWERS WHO DO NOT SMOKE | | | | | | | | |
| *Mean* | *13.07* | *14.21* | *13.21* | *13.93* | *14.0* | *13.34* | *13.64* | *13.64* |
| Standard deviation | 1.48 | 1.67 | 1.39 | 2.13 | 1.48 | 2.12 | 1.81 | 1.96 |
| Probable error of mean ± | 0.37 | 0.42 | 0.37 | 0.54 | 0.445 | 0.583 | 0.46 | 0.49 |
| Coefficient of variability | 11.3 | 11.7 | 10.5 | 15.3 | 10.6 | 15.9 | 13.3 | 14.3 |

following formula was applied: $x : 13.3 :: 24 : 22.5$, and solving for $x$ we have 14.19 as the number of standard-sized bottles which Operator 1 would make in one minute. Individuals who had worked on several different weight bottles were found to have outputs for the different weights corresponding to our curve, confirming the validity of our method. Furthermore, as will appear in a subsequent paper, the relationship of weight of gob to the number of gatherings per minute involves the time of gathering, of transfer back and forth, and of dropping the glass. The last two factors vary in an arithmetical progression, and the time of gathering, in a geometrical progression. The form of our curve is a logical outcome of these relationships.

The formula given above was used to reduce the output to terms of a standard-sized bottle so that the men could be directly compared as to output. The actual average output rate of the men in $8\frac{1}{2}$-ounce bottles per minute for each hour during the day's work, calculated by the method described above, is given in Table 2. The percentage output is also given in Table 2 and serves as a check on the former, as the percentage output is determined directly from the actual number of bottles which each man makes, reduced to a percentage on the basis of his average as

100. The two sets of figures vary in the same manner throughout the day, except for minor differences which prove to be due to the smoothing effect of the formula method, for if the percentage output curve is smoothed it approaches the actual output curve even more closely.

### Output Rate by Habit Groups

In order to determine the output of each group the standardized output records were added and the mean output rate per minute for each hour was obtained. For the eighty-five men studied the mean rate per minute for the day was 13.56, and for the seventy-six men in the habit groups the output was 13.99. The output rate for each hour was about the same throughout the day (see Table 2), showing that fatigue does not affect the output rate to any appreciable extent. Table 3 shows that all the habit groups are equal in this regard. The question of fatigue will be taken up in a separate paper.

The mean output rate for the day for each of the thirteen habit groups is shown in Table 4. The highest output is found in the heavy smokers who do not chew, and the lowest in the light smokers who chew. The difference between these two extremes is 1.01 bottles per minute, or 7.2 per cent. of the grand average output. Industrially, this is an important difference, amounting to more than a thousand bottles in a twenty-four-hour day. Statistically, however, the difference is so slight that before we can draw any conclusions, some statistical criterion must be applied to determine whether or not it has any significance.

The probable error of the mean can be used to determine the degree of unreliability of the mean; therefore, if we are comparing two means, the significance of the difference between them will be determined by the chances that one mean will coincide with the other. The chances that the difference between the means is significant are 1 : 1 if the probable error of the difference is contained once in the difference; 4.5 : 1 if contained twice; and 21 : 1 if contained three times. It is usually considered that, in order to be significant, the difference between two means must contain the probable error of the difference twice, and in order to have a degree of certainty, must contain it three times. We

TABLE 4. — MEAN OUTPUT RATE FOR DAY BY HABIT GROUPS

| Group | True Mean | Standard Deviation | Coefficient of Variability | Probable Error of Mean |
|---|---|---|---|---|
| Heavy smokers who do not chew | 14.33 | 2.4 | 16.9 | ±.101 |
| Non-users | 14.24 | 1.32 | 9.25 | ±.130 |
| All non-chewers | 14.24 | 2.3 | 16.1 | ±.078 |
| Non-chewers who smoke | 14.19 | 2.17 | 15.2 | ±.078 |
| All heavy smokers | 14.14 | 2.32 | 16.4 | ±.093 |
| Mean of all habit groups | 13.99 | .. | .. | ... |
| All smokers | 13.93 | 2.13 | 15.3 | ±.065 |
| Light smokers who do not chew | 13.88 | 1.54 | 11.0 | ±.099 |
| All non-smokers | 13.87 | 1.66 | 12.0 | ±.112 |
| Heavy smokers who chew | 13.72 | 0.3 | 2.2 | ±.025 |
| All chewers | 13.59 | 1.4 | 10.3 | ±.066 |
| Non-smokers who chew | 13.44 | 1.82 | 13.3 | ±.169 |
| All light smokers | 13.37 | 1.61 | 12.4 | ±.089 |
| Light smokers who chew | 13.32 | 1.37 | 10.3 | ±.114 |

have, therefore, arranged in Table 5 the differences between groups that can be compared and the number of times the probable error of the difference is contained in these differences.

From Table 5 it appears that chewing has a marked effect on output rate, while smoking has little effect. The non-user group may be considered as a standard, and we find that the whole group of non-chewers coincides with it in output rate, but the chewers fall far below these two groups, the difference being significant as the probable error of the difference is contained 2.7 times. The difference between smokers who do not chew and the non-users is too small to be of significance;

therefore, it appears that smoking has less effect on output rate than chewing. When we separate the smokers who do not chew into light and heavy smokers, no significant difference appears between the non-users and the light smokers or between the non-users and the heavy smokers. The heavy smokers who do not chew do slightly better than the non-users, but the difference is not statistically dependable. The light smokers who do not chew, however, do less well than the non-users, but the chances that this is significant are only 1 : 1. We cannot offer an explanation of the fact that the light smokers have a lower output rate than the heavy smokers. A difference of the same nature, however, exists between the output of heavy and light smokers as a whole, the probable error of the difference being contained in the difference 1.9 times, and also between the heavy and light smokers subdivided into chewers and non-chewers, the probable error of the difference being contained 1.1 and 1.0 times, respectively.

The fact that chewing has a much more marked effect on output rate than smoking is further brought out by a comparison of heavy smokers who chew with heavy smokers who do not chew, in which the difference is large enough to contain the probable error of the difference 1.8 times, and in like manner among the light smokers where the difference contains the probable error of the difference 1.2 times. These comparisons are also given in Table 5 and show that chewers have in every case a markedly lower output rate.

Table 6, in which the groups holding the highest and lowest hourly records are given, shows that the workers who chew in no case make a highest output rate record, but in seven out of eight of the hours make a lowest record. The actual output rates are given in Table 3.

TABLE 5.—COMPARISON OF HABIT GROUPS, SHOWING SIGNIFICANCE OF DIFFERENCES

| Groups | | Algebraic Difference from Mean of First Group | Probable Error of Difference | Number of Times Probable Error of Difference is Contained in Difference |
|---|---|---|---|---|
| First Group | Second Group | | | |
| Non-users | All chewers | −0.65 | 0.24 | 2.7 |
| " | Non-chewers | .... | .... | .... |
| " | Smokers who do not chew | −0.05 | 0.28 | .... |
| " | Light smokers who do not chew | −0.36 | 0.34 | 1.0 |
| " | Heavy smokers who do not chew | +0.09 | 0.34 | .... |
| All heavy smokers | All light smokers | −0.77 | 0.41 | 1.9 |
| Heavy smokers who do not chew | Heavy smokers who chew | −0.61 | 0.33 | 1.8 |
| Light smokers who do not chew | Light smokers who chew | −0.56 | 0.18 | 1.2 |
| Heavy smokers who do not chew | Light smokers who do not chew | −0.45 | 0.45 | 1.0 |
| Heavy smokers who chew | Light smokers who chew | −0.40 | 0.37 | 1.1 |

## Discussion

From the foregoing data it appears that workers who chew have a much lower output rate than those who only smoke or who do not use tobacco in any form. The light smokers, however, do show some inferiority in output rate and the heavy smokers a very slight superiority, although these differences are too small to be statistically dependable. The difference between the light and heavy smokers is apparently significant. The fact that light smokers have a lower output rate than heavy smokers is difficult to explain but may be an indication that insufficient use of tobacco has more deleterious effects than a larger use which might confer an immunity

that would be lacking in the case of light smokers. This explanation is entirely a surmise, but should be followed up.

The low output of chewers may be due to a greater absorption of nicotine into the system than takes place from smoking. Some reason for this is obvious when we consider that in smoking at least half the nicotine is lost in the smoke from the burning point and that a large part of the nicotine in the inhaled smoke may be exhaled before it is absorbed. This is quite likely, as smoke can be drawn through several wash bottles without losing all its nicotine, because the alkaloid is probably adsorbed on the surface of liquid particles in the smoke which are notably difficult to absorb in a wash bottle. (This point will be brought out in a paper to follow shortly.) In chewing tobacco, on the other hand, the saliva of the chewer seems to have ample opportunity to absorb the nicotine of the tobacco, and from the saliva the mucous lining of the mouth may absorb the poison. Furthermore, in most chewing a certain amount of saliva is swallowed, which gives abundant opportunity for absorption of nicotine. It is possible, therefore, to offer an explanation for the fact that chewers have a lower output rate than smokers on the basis of the relative nicotine absorption, although until actual absorptive studies of the two groups have been made, such an explanation can be only tentative.

TABLE 6.—HABIT GROUPS HOLDING HIGHEST AND LOWEST HOURLY OUTPUT RATE RECORDS

| Hour | Highest Average Hourly Output Rate | Hour | Lowest Average Hourly Output Rate |
|---|---|---|---|
| 1 | Heavy smokers who do not chew | 1 | Chewers who do not smoke |
| 2 | Heavy smokers who do not chew | 2 | Heavy smokers who chew |
| 3 | Non-users. . . . . . . . . . . | 3 | Light smokers who chew |
| 4 | Heavy smokers who do not chew | 4 | Light smokers who chew |
| 5 | Heavy smokers who do not chew | 5 | Light smokers who do not chew |
| 6 | Heavy smokers who do not chew | 6 | Chewers who do not smoke |
| 7 | Heavy smokers who do not chew | 7 | Light smokers who chew |
| 8 | Non-users . . . . . . . . . | 8 | Light smokers who chew |

## Conclusions

1. Smoking has little effect on output rate in the strenuous physical occupation studied by us.

2. Chewing markedly lowers output rate in this strenuous physical occupation.

3. Light smokers have a slightly lower output rate than heavy smokers in this strenuous physical occupation.

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# A SURVEY OF CARBON MONOXIDE POISONING IN AMERICAN STEEL WORKS, METAL MINES, AND COAL MINES*

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THIS report is the result of a survey, chiefly in mines and about blast furnaces, to obtain more accurate information regarding the clinical effects of carbon monoxide.

In the United States and abroad the literature gives many instances of mental impairment, psychoses, and paralyses following acute gassing by carbon monoxide, and it is stated that anemia, neuritis and other symptoms follow chronic poisoning from this gas (1) (2). It undoubtedly causes more accidents, fatal and non-fatal, than any other gas in industry, and it seems important to find out how much crippling and how much loss of working time it is responsible for. Few accurate data are to be found in regard to this, and two definite problems, therefore, present themselves: (1) How frequent are late sequelae of acute carbon monoxide gassing? and (2) What effect does the gas have on men frequently exposed to small doses?

An attempt to answer these questions has been made by a survey of metal mines, coal mines, blast furnaces, and producer gas boilers and engine rooms in Montana, Colorado, Oklahoma, Arkansas, Alabama, Tennessee, Kentucky, and Pennsylvania. Data were obtained from mine hospitals, mine doctors, United States Bureau of Mines officials, superintendents, foremen, shift bosses, fire bosses, and individual miners, as well as by inspection of the less well ventilated workings and of drifts and stopes near fire areas. In a few cases red blood-cell counts were made, and in others, tests for carbon monoxide in the blood.

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In mines, exposure to carbon monoxide usually occurs in one of three ways: (*a*) after explosions or during serious fires; (*b*) about smouldering fire areas; or (*c*) after blasting. Carbon monoxide is the chief poisonous element of the miners' "white damp," "after damp," and "powder smoke." Its presence in 0.025 per cent. is sufficient to cause dizziness and severe headache; in 0.2 per cent. it is dangerous (3).

In Montana the copper mines at Butte and the smelters at Anaconda, East Helena, and Great Falls were examined. The smelters appear to present no carbon monoxide hazard under ordinary conditions. In the copper mines, the gas does occur frequently in small amounts about the fire areas and is rather troublesome. Occasionally, also, it causes headaches after blasting at certain points where the air current is not good and where two or three shifts are working. In these mines there is no record of lost time due to this cause, and only rarely is a man overcome for a few hours about the fire areas. In the coal mines, especially in the South, owing to the danger of explosions from natural gas and fine coal dust, there is always free ventilation, and the powder smoke only occasionally causes symptoms. The iron ore mines near Birmingham, Alabama, are less well ventilated and after blasting the carbon monoxide lies in the fine dust and is stirred up by the "muckers," who often have headaches from it. But there is apparently no lost time from this cause.

About the blast furnaces the gas seems to cause practically no loss of time among the men most frequently exposed to small

percentages of it — *i. e.*, the top-fillers, hot blast men, or the men tending the boilers or engines run by producer gas. Among the pipe-fitters and repair men who encounter occasional high percentages of carbon monoxide, loss of time is fairly common, but the man gassed usually lies down for a few minutes and then returns to work. Only a small proportion of these cases are sent to the hospital, and the company office has no record or even knowledge of them. In the large plants, such as those at Pittsburgh, the number of hours lost in this way must be considerable.

## Acute Carbon Monoxide Poisoning

*Symptoms.* — The symptoms of acute carbon monoxide poisoning may vary from sudden unconsciousness without warning to merely a slight headache. The usual symptoms, in the order of their occurrence, are: dizziness or sense of fullness in the head, frontal headache, weakness of the knees, nausea, sometimes vomiting, general weakness, inability to walk or stand, and unconsciousness. The symptoms depend chiefly on the concentration (3) of carbon monoxide and on the duration of exposure, but also vary with the individual and his physical condition at the time of gassing. Often there is a stage of excitement like alcoholic intoxication. Different persons react as differently as they do to alcohol, and many men are well known to be able to stand amounts of the gas which would speedily overcome others. The most sensitive are men with pre-existing pulmonary or cardiac disease. Sudden entrance into cold air or sudden exertion causes an exacerbation of symptoms. Gastric indigestion and constipation seem to make a man temporarily more susceptible to carbon monoxide.

*Sequelae.* — In severe acute gassing, when unconsciousness has lasted minutes or hours, the usual after-effects are intense headache, fatigue, and muscle pains, lasting from one to three days. It is interesting that the muscle after-pains appear to be worst in those muscles most used during exposure to the gas. The temporary character of the effects of acute gassing, however, are illustrated by the following instances. In a mine disaster in Butte, Montana, twelve cases were admitted to the hospital, gassed. Nine left relieved in twenty-four hours, and the other three, two days later. No readmissions and no known sequelae occurred. In another hospital, in the past year ten miners were admitted, gassed in mine accidents. Nine went home in twenty-four hours or less. The tenth, unconscious at entry, stayed thirty-six hours. This patient had always been neurotic, a state which was accentuated after the gassing, but no new condition developed. There were no re-entries and no sequelae. The same story was told everywhere by miners, foremen, and mine doctors of many years' experience. They knew of no men permanently incapacitated through mental or physical injury from gassing. One Bureau of Mines official, however, knew of two men gassed after a coal mine dust explosion, who were mentally incapacitated some months later. It was not known what their mental or physical condition had been before being gassed. Another Bureau of Mines engineer said that two other men had been partly paralyzed after short exposure to mine gas. The history given suggested complicating disease or hysteria as the probable explanation, but no clinical details were obtained. Cases of pneumonia following gassing were rare and occurred usually when smoke or irritating gases were present.

About blast furnaces the testimony was the same — almost no late nervous or mental sequelae were known. Two cases of mental impairment were reported by company doctors, one of which occurred in a chronic alcoholic, the other, in a man who

had a strongly positive Wassermann. Concurrent disease, and especially cerebral arteriosclerosis, seems to be a very important factor in causing cerebral lesions in a person severely gassed (4). In fact, if a young, healthy adult is severely gassed by "white damp" or by blast furnace gas, he either dies in a few days or recovers entirely — a rule to which there are few exceptions.

## Chronic Carbon Monoxide Poisoning

In regard to the question of chronic carbon monoxide poisoning, it was found that in certain mines about the fire areas men were exposed to "white damp" almost daily for months. While at work, these men complained of frontal headaches which sometimes lasted till they fell asleep. Next morning they felt well again unless the exposure to carbon monoxide had been unusually severe, in which case they suffered from headache and felt "all in" for a day or two. But at any time if they stopped work and stayed outdoors for a day or so, all symptoms disappeared.

Some men notice a certain degree of tolerance when working frequently in the gas. For example, a mine foreman, whom I questioned — a man 50 years old — had done mine work since he was a boy. For months at a time he had had enough gas to cause daily headaches, yet was sure that at the end of such a period he could stand more gas than he could at the beginning and more than a "green" man working beside him could stand. Tolerance to carbon monoxide has, moreover, been demonstrated experimentally by Nasmith and Graham (5), and has been noticed before in man by Haldane (6) and others. Most miners noticed neither tolerance nor cumulative ill-effects. A few veteran miners, however, thought that they had never been quite so strong since a series of severe gassings. Such a man was a fire boss who had been under tremendous strain, emotional and physical, fighting a fire for eighteen months in a coal mine. He had always been able to stand a large amount of "white damp" and had never been rendered unconscious by it, though many times men beside him had been overcome. He stated that for months after this ordeal he was nervous and his hand shaky. He believed also that his heart was affected, as he noticed palpitation and precordial distress on exertion or on entering gas, yet he admitted that, even now, he could stand as much gas as most men. This man had had no careful medical examination. The fire in question occurred thirteen years ago and he had been at work constantly ever since.

*Anemia.* No evidence of anemia resulting from frequent exposure to carbon monoxide was found, either in the reports of the doctors or in red blood-cell counts. These counts and many more previously taken from Illinois blast-furnace workers show polycythemia rather than anemia. In 1911 Karasek and Apfelbach (7) examined sixty-eight steel workers. The red blood-cell counts in their cases ran between 5,500,000 and 9,600,000, two-thirds being over 6,000,000. The appearance of the red blood-cells was normal. Dr. Davis, chief surgeon of the Illinois Steel Company (8), reports that 175 red blood-cell counts taken at Gary and in South Chicago on men who had worked in the blast furnace and open hearth departments for years showed no counts below 4,000,000; 64.1 per cent. over 5,000,000; and 2.2 per cent. over 6,000,000. Physical examinations of these men showed no lesions of the nervous system.

*Neurological Symptoms.*— No histories were obtained from miners or mine doctors suggestive of multiple neuritis, mental deficiency, or paralysis following chronic carbon monoxide exposure. Even with illuminating gas, which has been shown to be more toxic than pure carbon monoxide (9), no serious nervous or mental results

seem to be common, at least after acute exposure. In the past two years, 134 cases of acute illuminating gas poisoning were admitted to the wards of the Boston City Hospital. Of these, not one patient has been readmitted with neurological symptoms or committed to an insane hospital unless a definite pathological condition existed prior to the gassing. This information was obtained by personal examination of the hospital records.

*Tests for Carbon Monoxide in Blood.* — In the mines it was difficult to find men actually suffering from carbon monoxide headaches at the moment and it was useless to examine the blood of miners for carbon monoxide after they had walked to the hospital, for they had then lost the gas through respiration. The few specimens taken in mines at the working face were negative. About blast furnaces, however, there was one situation where men inhaled carbon monoxide at intervals all through the day, and every day. These men were the top-fillers on the old style hand-filled furnaces. Blood specimens from two of such workmen out of six tested were positive for carbon monoxide hemoglobin. The tannic acid test was used (10) and the blood was taken while the men were actually at work on the furnace top. The two patients whose tests came out positive had complained of slight headache at the time the blood was taken. Some of these top-fillers had done this work for years (one for twenty years) without apparent injury to their health.

### Treatment

Carbon monoxide does not form a permanent combination with hemoglobin. This has been conclusively shown by Haldane (11), Henderson (12) and others. The affinity of hemoglobin for carbon monoxide is approximately three hundred times that for oxygen, but the reaction is reversible. As soon as the man breathes oxygen or fresh air, the oxygen exactly replaces the carbon monoxide in his blood, molecule for molecule, at a speed depending on the partial pressures of the two gases in the alveoli. The red blood-corpuscles are apparently uninjured and are able to take up and transport oxygen normally as soon as the carbon monoxide has been expelled.

In the treatment of carbon monoxide poisoning, bleeding, as Haldane and Henderson have clearly stated, is harmful. Transfusion is unnecessary because under proper treatment the blood can be brought back nearly to normal within half an hour. The most recent advance in treatment has been made by Henderson (9), who advocates administering with oxygen a small percentage of carbon dioxide, to induce better pulmonary ventilation. Henderson's results are striking. In his experiments dogs were gassed thirty to forty minutes with illuminating gas in such dilution as to give 0.4 per cent. carbon monoxide, until they became completely unconscious. Untreated, these animals took approximately two hours to exhale sufficient carbon monoxide from their blood to reduce the percentage of this gas to 10 per cent. With oxygen treatment alone, this result was attained in sixty to eighty minutes; with oxygen and carbon dioxide it took only twenty minutes.

Another advance of real importance in protection against carbon monoxide is the perfecting of an efficient respirator by the U. S. Chemical Warfare Service (13). The cannister of this respirator is smaller than the army type and is effective even at zero degrees against 1 per cent. of carbon monoxide. Its life is approximately three hours. Information in regard to it can be obtained from the Director of the Bureau of Mines, Washington, D. C.

### Summary

Carbon monoxide as met with in metal and coal mines and about blast furnaces in this country rarely causes late after-effects following acute severe gassing. When such effects do appear, there is evidence, almost always, of a pre-existing pathological condition.

Frequent exposure to carbon monoxide causes headache and malaise, but no evidence has been found of a cumulative harmful effect.

As was to be expected, owing to the compensating increase of hemoglobin and red cells from prolonged oxygen want (14) (15), it is possible to acquire some tolerance to carbon monoxide.

A recent advance in treatment has been made by adding carbon dioxide to the oxygen inhalations administered. Recovery is three times as rapid as when oxygen alone is used.

An efficient portable carbon monoxide respirator has been perfected by the U. S. government.


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# A DISCUSSION OF THE ETIOLOGY OF SO-CALLED ANILINE TUMORS OF THE BLADDER*

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FOR the last twenty-five years the Germans have been aware that there is an undue prevalence of malignant tumors of the bladder in aniline dye workers. The first to call attention to this curious fact was Rehn (1), who presented before the German Surgical Society in 1895 the histories of three cases of malignant bladder tumor in employees of one of the great dye works, the men forming part of a force of forty-five who were employed in making fuchsin. Rehn concluded as follows:

> For the majority of bladder tumors one can only assume that compounds excreted by the kidneys and existing in solution in the urine are capable of setting up tumor formation through chemical irritation. So far these compounds have eluded our search. . . . The gases produced in the manufacture of fuchsin lead to disturbances of the urinary system, and prolonged employment over many years in the fuchsin department may cause the development of bladder tumors because of continual irritation. The harmful effects depend essentially on the inhalation of aniline fumes.

The manufacture of fuchsin consists in heating a mixture of aniline, ortho-toluidine and para-toluidine, with nitrobenzene, or ortho-nitrotoluene and para-nitrotoluene, in the presence of iron and hydrochloric acid.

This theory of Rehn's was challenged immediately, especially by Grandhomme, the chief authority on industrial poisoning in color manufacture, since he had been for many years in charge of the great plant at Hoechst-am-Main. Grandhomme admitted that aniline was irritating to the bladder mucosa, as shown in observations on men and on animals, but as to its being responsible for tumor growth, he pointed out the fact that, while Rehn had found three cases among forty-five fuchsin men exposed to aniline fumes, there were in the factory at the time about 4,000 men exposed to the fumes. Eleven years later, however, Rehn (2) was able to present to the German Surgical Society records of thirty-three cases which he had collected from German dye works, all malignant and all occurring between 1889 and 1906. To these, Seyberth added five, others three, making forty-one in all.

In 1912, Leuenberger (3) of Basel presented a paper before the same society in which he reviewed the whole subject of the occurrence and causation of bladder tumors in aniline workers and added eighteen cases from the works in Basel, which had then been running for about twenty-seven years. He specially urged physicians attached to dye works to study these tumor cases and to try to discover the substances responsible for them. The following year the German Congress of Industrial Physicians endorsed Leuenberger's request and drew up a set of questions to be answered in connection with each case of bladder tumor. This questionnaire was sent to all the German and Swiss dye works. The results of the studies made since then are now appearing in the German medical journals. Many new cases have been added to Leuenberger's list of fifty-nine, and in the last article on the subject, by Curschmann (4), the final corrected list includes 177 cases.

The statistics on which the Germans base their statement that bladder tumors

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are strikingly frequent among aniline workers are not satisfactory. They are incomplete in several respects, and it is surprising that when so much careful clinical and experimental work has been done in this field, nobody has troubled to present indisputable proof of this basic statement. We do not know how many men are exposed to fumes, and cannot tell, therefore, what proportion of the whole such a number as 177 is. The number of employees in these dye works is estimated at 80,000 to 100,000 — an estimate which is more dependable, owing to the small labor turnover, than would be a similar one in our dye works. Nassauer (5) gives the labor turnover for one of the plants in the Frankfurt region as only 15 per cent. per year. That would be more nearly the monthly turnover in an American plant. During the war, however, there must have been a great deal of shifting; indeed, Nassauer speaks of the introduction of women workers and speculates as to the probable appearance of bladder tumors among them during the next twenty years.

The exact number of men exposed to what is regarded as the exciting cause of tumor growth is not the only missing link in the train of reasoning on which the Germans base their statement that dye workers have more than their due proportion of bladder tumors. The figures given by Rehn for the Frankfurt region are as follows: Between 1895 and 1918 there were 92 cases of bladder tumor in the City Hospital, 22 of which were unquestionably caused by aniline and 24 possibly so caused, making 46 or 50 per cent. of the whole number. The proof would be much more convincing if the records showed what proportion of the male population of the hospital was employed in the dye works. The same criticism applies to Leuenberger's figures from the Basel hospital, which cover fifty years. (See Table 1.) Nassauer's plant (5) had 32 cases in twenty years, with a working force of 105 men and an annual turnover of about 15 per cent. This is really the most striking record offered in the literature, but Oppenheimer (6) believes that the proportion is higher than that given in any official report. According to the tales of his patients there was one factory with 60 men in which during twelve years 15 cases appeared: in another with 60 men there were 27 cases,

TABLE 1. — CASES OF BLADDER TUMOR IN BASEL HOSPITAL, 1861–1910

| Years | Number of Male Patients | Number of Cases of Bladder Tumor: In Hospital | In Color Makers | In Dyers |
|---|---|---|---|---|
| 1861–1870 | 2600 | 1 | 0 | 0 |
| 1871–1880 | 3450 | 0 | 0 | 0 |
| 1881–1890* | 4250 | 1 | 0 | 0 |
| 1891–1900 | 5500 | 4 | 0 | 0 |
| 1901–1910 | 9650 | 16 | 10 | 2 |

* The dye industry began in Basel in 1885.

9 of which were known to have been fatal; and in a third, 29 out of 30 men died of bladder disease in ten years' time.

A typical history of the earlier cases of bladder tumor reads as follows: The man comes to the plant doctor for treatment usually because he has noticed blood in the urine. Cystoscopic examination * then reveals a papillomatous growth, more rarely a flat carcinoma with a broad base. In more recent years, since physicians have been on the watch for these tumors, the examination is often made before the appearance of blood and discloses sometimes only a cystitis, with ulceration perhaps, then later on, even if the man is removed from contact with aniline, a new growth is found. Different varieties are described — pediculated papilloma, villous polypus, wart-like excrescences, or general papillomatosis of the whole bladder. These benign growths may undergo carcinoma-

* The use of the electric cystoscope was first introduced in 1880 in Germany by Nitze, and undoubtedly as its use extended many early cases of tumors were discovered which formerly would have gone undetected.

tous degeneration, but there are also malignant growths which are quite different in appearance and which apparently have not passed through the papillomatous stage, being solid, with a broad base (6). In some instances, a small fresh polyp can be seen on one side of the bladder, and a carcinoma on the other. The cancerous growth may invade the neighboring lymph glands or the ureter and kidney, as in one of Rehn's cases, or the bones of the pelvis and the lower abdominal wall, as in a case seen by Czerny. Only one autopsied case has shown metastases in liver and lungs. In the earlier cases, it was said that the seat of predilection was near the mouths of the ureters, but later reports showed that they might be situated in any part of the bladder.

A long exposure to the chemical which is the exciting cause seems to be necessary. The statistics from Hoechst, Ludwigshafen, and Greppin (7) show that the cases developing in the fuchsin department were in men who had been employed on an average from twelve years in Greppin to nineteen in Ludwigshafen. Those who worked in the benzidine-naphthionic department had had a shorter period of exposure, averaging five years in Ludwigshafen, and six years in Greppin. Oppenheimer's patients had worked from two to twenty-eight years, averaging eighteen years. The two-year case, which was far below the average — indeed, the shortest exposure on record so far — occurred in a man who worked in the benzidine department.

Both Curschmann and Oppenheimer find that there is no connection between the length of exposure and the malignant character of the growth, nor is there any relation between the particular compound causing the tumor and the character of the tumor. Oppenheimer observed six men who had worked together in the same room for twenty years; two were healthy, two had been operated on for bladder tumor and had recovered, and the last two had died from bladder tumor. Of Curschmann's twenty-six cases, one developed after five years, six after five to ten years, six after fifteen to thirty years, and thirteen after more than thirty years' employment. The Basel cases did not begin to appear till the industry was 16 to 17 years old, and in England the only dye works in which information about bladder tumors among the men can be obtained is the oldest one, more than 20 years old. Curschmann finds the great majority of cases of cystitis among dye workers as reported in the literature occurring after 40 years of age. Oppenheimer's twenty patients were between 34 and 47 years of age, decidedly younger than the average for bladder tumors in general.

The histories of color makers who suffer from bladder tumors show that ordinary aniline poisoning has nothing to do with the condition in the bladder. A man may have had repeated attacks of acute aniline poisoning or the chronic form of poisoning, yet never have even a cystitis; or he may never have had typical aniline poisoning and yet develop a tumor of the bladder.

One very interesting feature of this variety of bladder tumor was brought out by Leuenberger and confirmed by Schwerin (7) and by Oppenheimer — namely, the fact that the tumor may develop long after the exposure to the exciting cause has ceased. Leuenberger tells of a man who worked in benzidine for seven years, had cystitis, and was transferred to another department where he worked for two years. He then left the factory, and two years later blood appeared in the urine and he was operated on for tumor of the bladder. Schwerin of Hoechst reports two similar cases: one, a man who worked five years in the benzidine-naphthionic department and twenty-three years later had tumor of the bladder; the other, a man who worked eleven years in aniline and eight years after

leaving the factory had a tumor removed from the bladder. Oppenheimer saw tumors develop ten years and seventeen years after the men had left the factory.

It seems from the observations of Nassauer and of Oppenheimer that an extremely slight exposure to the exciting cause is sufficient. Oppenheimer had three cases which developed in men who never came in contact with the chemicals, but who worked in rooms adjoining the process departments. These cases were slow, the tumors developing after twenty to twenty-six years. Several of Nassauer's patients were employed in departments in which no manufacturing was carried on but which were next to the departments making benzidine.

In the search for the exact compound or compounds which are responsible, a careful study has been made of the history of each case so far reported, in order to see which of the intermediates used in color manufacture seem to be connected with bladder tumors. A great variety of compounds emerge as probable agents, compounds with different degrees of toxicity and with different physical and chemical properties, but with this feature in common, that they are all amido compounds, containing the radical $NH_2$, produced by the reduction of nitro compounds. The latter, though distinctly more toxic than the amido group, do not have this peculiar effect. These are the lists which have been submitted:

*List from Hoechst-am-Main* (7)

| | |
|---|---|
| Naphthylamines | 30 cases |
| Benzidine and naphthionic acid | 28 " |
| Fuchsin | 21 " |
| Aniline | 8 " |
| Black and blue colors | 4 " |

*Curschmann's List* (4)

| | |
|---|---|
| Beta-naphthylamine | 10 cases |
| Aniline | 5 " |
| Fuchsin | 3 " |
| Benzidine-naphthionic | 3 " |
| Other bases | 3 " |
| Blue colors | 4 " |

*Oppenheimer's List* (6)

| | |
|---|---|
| Aniline | 3 cases |
| Aniline colors | 2 " |
| Benzidine | 5 " |
| Aniline-naphthylamines | 3 " |
| Aniline-benzene-toluene | 1 " |
| Benzidine-aniline | 1 " |
| Benzidine-tolidin | 1 " |
| Amido-naphthol-cresoldicarbonic acid | 1 " |
| Naphthylamine-cresoldicarbonic acid | 3 " |
| Not directly exposed | 1 " |

Nassauer gives the following substances in connection with which bladder tumors have appeared: aniline, para-toluidine, xylidines, cumidins, naphthylamines, fuchsin, benzidine, tolidin, and blue rosaniline coloring matters made from fuchsin by the action of aniline in the presence of acetic or benzoic acid.

In trying to determine which of these compounds is the responsible agent, there are several difficulties which must be borne in mind difficulties encountered more or less in every study of industrial poisoning, but especially in connection with such complicated processes as those of dye manufacture. In the first place, every process involves the use and production of more than one compound, so that even if a man is engaged in only one process it cannot be said that he is exposed to only one poison. Moreover, it is very common to have two distinct processes going on in the same room, so that the workmen are exposed to other compounds than those with which they are working. The benzidine-naphthionic department, mentioned so often in connection with bladder tumors, is one in which Congo red is manufactured from benzidine, which is a product of nitrobenzene, and from naphthionic acid, which is a product of alpha-naphthylamine. The harmful substance here has sometimes been considered benzidine, sometimes alpha-naphthylamine — neither of which is markedly toxic — while Nassauer believes

that it is the small percentage of aniline accidentally formed in the conversion of nitrobenzene to benzidine. Nor must it be forgotten that certain poisonous substances may be formed accidentally in the course of industrial processes, and their presence not suspected, as when hydrogen sulphide is given off in the making of sulphur dyes, or hydrogen arsenide in various reduction processes.

Industrial conditions bring about other difficulties which are especially evident when the form of poisoning to be studied is very slow, drawn-out over a great many years. Workmen change from one department to another, and each change brings new compounds into question, or they go from one factory to another, in which the processes are different. It is also true that the same compound used in different processes may be attended with very different degrees of danger. Thus, it is said that in the making of benzidine there may be more actual exposure to aniline vapor than in the manufacture of aniline itself.

These difficulties strike one forcibly when one tries to bring into some sort of harmony the results of the studies in the different German factories. For instance, Nassauer believes that all the cases in the literature can be traced to one department — the manufacture of benzidine. He has been very strongly impressed by the dangers in benzidine manufacture, but then, it is obvious that the plant with which he is connected makes benzidine chiefly, producing before the war 60 to 70 per cent. of the world's supply. It is easy to understand, therefore, why he finds that every one of the thirty-two cases which occurred there were in men who had been working in or near or outside of the benzidine rooms. Curschmann of Hoechst and Engel (8) of Ludwigshafen find a singularly large number of cases in men exposed to beta-naphthylamine, but Nassauer insists that this compound could not be responsible since he has never seen a case of hematuria or strangury in a naphthylamine worker in twenty years, and he believes that there are other fumes in the naphthylamine departments.*

The Hoechst investigators, Schwerin (7) and Kuehenbecker (9), agree with Nassauer that the greater number of cases come from the benzidine-naphthionic department. They do not attribute this to aniline fumes, however, but to benzidine dust. The earlier reports of bladder tumors placed the danger in the fuchsin department. Aniline began to be used on a large scale for the manufacture of fuchsin in 1872 and about twenty years later the reports of bladder tumors in aniline workers began to appear. But aniline is not the only compound used in fuchsin manufacture; ortho-toluidine and para-toluidine must also be considered.

The causation of these tumors is a subject at present occupying most of the attention of the German investigators, for obviously it is a matter not only of scientific but of practical importance, as no efficient system of prevention can be devised until the dangerous substances are discovered. Experiments on animals have so far cast very little light on the subject. It has been known for a long time that irritation of the bladder could be produced by injection of aniline and some of its homologues, and such dye intermediates as tolylenediamine, phenylenediamine, and paranitraniline will set up not only irritation of the bladder mucosa but also hemorrhage. As soon as the administration of the poison is suspended, however, the symptoms subside, nothing further occurs, and the bladder mucosa becomes quite normal again. Nor are these particular com-

* Hematuria and strangury have been reported, however, in connection with beta-naphthylamine by German factory inspectors and in the one American factory where I have seen it used it has been found decidedly more toxic than alpha-naphthylamine, causing frequent, burning micturition, as if the urine were over-acid, as Engel has found it to be in dogs which have been fed beta-naphthylamine.

pounds connected with cases of bladder tumor in dye workers. Oppenheimer tried to produce tumors in animals by repeated injections of benzidine and tolidin in suspension, but although he continued his experiments for eighteen months, there was absolutely no result.

Leuenberger recalls the work done on aniline excretion in Schmiedeberg's laboratory (10), which showed that aniline undergoes in the body hydroxylation to para-amidophenol and is excreted in the urine in conjugation with ethyl sulphuric acid. He maintains that it is this hydroxyl derivative of aniline and similar bodies which sets up proliferative processes in the whole urinary tract: first, inflammatory infiltration and atypical proliferation of the mucosa, then, papilloma formation, granuloma, carcinoma, sarcoma, and mixed forms. He assumes a precancerous stage of inflammation and proliferation, such as occurs in arsenical granuloma and epithelioma, in X-ray lesions, and in the so-called pitch cancer. The late development of the tumors he explains by the fixation in the body of decomposition products of the poisons, with continual damage to the bladder cells, or the effect of the chemical may be passed on through successive generations of cells. He points out the similarity between these aniline tumors, which are clearly caused by some chemical irritant, and other growths which are known to be the result of chemical irritants, such as the cancer of chimney sweeps so thoroughly studied by the English, and the cancer of briquette makers first reported by Volkmann, then by the English, in all of which there is, first, irritation of the skin, then, the formation of warts, or nodules, or sclerodermatous patches. If the man leaves work, nothing more serious may occur, but if his exposure is prolonged, slow carcinomatous degeneration sets in.

Nassauer also compares aniline workers' tumors to the pitch and tar cancers described by the English, and he speaks of a curious observation made among the miners of cobalt arsenide ore in the Saxon Erzgebirge, who were found to have an enormous incidence of lung carcinoma. As for the ability of aniline and similar bodies to set up proliferative changes in the bladder mucosa, there seems to be only one observation. Fischer (11) found that epithelial growth was stimulated by the injection of certain fat-soluble colors in oil. "Scharlach Roth" (amidoazotoluene) was the most active and has since been used to encourage healing after extensive burns.

Oppenheimer believes that there is a biological affinity of these poisons (benzidine, aniline, naphthylamines, tolidin, etc.) for the epithelium of the excretory part of the urinary system. The kidneys are not involved but the bladder is affected. He suggests that perhaps more than one substance is responsible, one sensitizing the tissue to the action of the other. The length of exposure to the exciting cause seems to be a matter of no importance. Oppenheimer agrees with Nassauer that a short exposure may set up the process which eventuates in a tumor. It is plain that the "revolution" in the tissue once begun keeps on after the cause is removed, *cessante causa non cessat morbus.*

According to Nassauer the irritative substance is always aniline, mixed with air. The condition is always produced by fumes, containing a quantity of aniline which is too small to set up clinical symptoms of intoxication, but which, dissolved in the moisture of the alveoli of the lungs (aniline is 3 per cent. soluble in water), penetrates the cells and reaches the lymph stream or the blood. A very dilute mixture of aniline with air, such as is breathed by men working in a room next to the one containing the source of aniline fumes, causes a more rapid tumor growth than does a larger quantity of aniline in the air, and the men who work out of doors, get-

ting only minute quantities of fumes from the nearby building, have an even shorter latent period. Nassauer considers the action of aniline so powerful that one year's exposure to the fumes is too long, and since 1904, in the factory under his charge, he has permitted only three months' employment in the benzidine department — in his opinion, the danger spot.

Leuenberger suggested that, since the amido compounds which seem to be responsible for tumor growth undergo hydrolysis in the body, it should be possible to ascertain which of the amido compounds used in the dye industry are eliminated in this particular form, as para-amidophenol, and then to check up the clinical cases and see whether they could be linked up with these compounds. To this Engel replies that there are several compounds apparently associated with tumor formation which do not undergo hydrolysis in the body and appear in the urine as para-amidophenol. For instance, para-toluidine is excreted unchanged, as is also alpha-naphthylamine, while diphenylamine undergoes a complete loss of the amido group.

Kuchenbecker also undertook to test this statement of Leuenberger's. Since a hydroxyl amido compound, containing as it does a free amido group, can be diazotized in acid solution with a nitrite and produce an azo color, it is comparatively simple to prove its presence. If aniline is administered to animals, a red azo color can be obtained in the urine, and the same result is obtained with ortho-toluidine, but not with para-toluidine. This is because aromatic amido compounds undergo such a change only if the para position is free, but not if it is occupied, as it is in para-toluidine. Kuchenbecker then fed benzidine to dogs and found a substance in the urine which was not a hydroxyl compound, nor was it benzidine. Practically the same result was obtained with tolidin. Alpha-naphthylamine is excreted unchanged and gives typical reactions with beta-naphthol. Beta-naphthylamine is also excreted unchanged. It seems impossible, therefore, that para-amidophenol should be responsible for the occurrence of bladder tumors, since all the last-named substances are apparently as much concerned in their causation as is aniline.

At present, Engel is conducting experiments with beta-naphthylamine, which apparently has been connected with a large number of tumors — an especially singular fact because it is not particularly volatile, and does not cause much ordinary industrial poisoning, and because there is nothing in the work that brings about unusual exposure. Engel wishes to discover whether beta-naphthylamine undergoes hydroxylation and, if so, whether amido-naphthol is formed or amido-dioxynaphthalene, and whether these are eliminated in conjugation with ethyl sulphuric acid or with glycuronic acid. So far he has been able to prove that after the administration of beta-naphthylamine to dogs, both acids are increased in the urine. If the animal is on a meat diet, it is the ethyl sulphuric acid which shows a marked increase; if on a carbohydrate diet, the glycuronic acid.

There the matter rests at present; the problem is no nearer solution than that. There is one compound, however, which must be considered as having a possible bearing on the occurrence of bladder tumors in dye workers and which is not mentioned by the German investigators — namely, hydrogen arsenide. The danger of arsenical poisoning in fuchsin manufacture was well known in the early days of the industry, for arsenious acid was one of the compounds used for oxidation in making fuchsin, as nitrobenzene is now. That method was discontinued about thirty years ago, but it is recognized in German dye works that accidental arsenical poisoning may still occur from an evolution of hydrogen arsenide not only in fuchsin

manufacture but in all processes where acid and metal are brought together and one of them is contaminated with arsenic. The chamber sulphuric acid of commerce, made from iron pyrites, is frequently thus contaminated, as is the hydrochloric acid made by the action of such sulphuric acid on sodium chloride, while both the iron scrap and the zinc dust used in reduction processes in the making of intermediates and colors may also carry arsenic as an impurity, the zinc dust especially. German dye works are so well guarded against the escape of fumes of all sorts that accidental poisoning of this kind is now decidedly rare, yet that it can occur is shown by the history of one of Nassauer's patients who suffered from hydrogen arsenide poisoning while making benzidine.

It is in the process of reduction that this danger is found. Two forms of reduction are used in the manufacture of intermediates, acid and alkaline or neutral. Nitrobenzene, subjected to acid reduction by nascent hydrogen from iron filings and hydrochloric acid, yields aniline. Nitrotoluene yields ortho-toluidine and paratoluidine. If either the iron or the acid contains arsenic as an impurity, hydrogen arsenide may form in the course of reduction, but in a well-managed plant this reaction is carried on in tightly closed autoclaves, and there is very little, if any, escape of fumes. However, when, in going through a very excellent German plant, I commented on the arrangements for fume removal in the aniline reduction room, I was told that the rule there was to allow no vapors of any sort to escape into the room because of the ever-present possibility of traces of arseniuretted hydrogen. Of course, if the apparatus is not perfect it will get out of order and men must go in and clean out the sludge and make repairs. Five mild cases of arsenical poisoning occurred in a British dye works from this source, but were recognized as such only because arsenic was found in the urine. Tests for arsenic are not made in American dye works and if such cases occur they are not recognized but are diagnosed as aniline or toluidine poisoning.

Alkaline reduction, used to produce benzidine and tolidin, is attended with much more danger of arsine poisoning than is acid reduction. Briefly, the process is as follows. Nitrobenzene, treated with zinc dust and sodium hydrate, is reduced first to azoxybenzene, then to azobenzene, and then to hydrazobenzene, which forms colorless crystals. At this point it is customary in Germany and in England to add hydrochloric acid, in order to form soluble zinc chloride, and get rid of the zinc by filtration. The temperature must be kept down by means of ice, or brine coils, because benzidine will form if it is warm and will be lost with the filtrate. In the summer of 1918 five cases of severe arsine poisoning with two deaths occurred in a British dye works where, in order to keep down the temperature of the hydrazobenzene-zinc-hydrochloric acid mixture, the reducer was opened and a chunk of ice dropped in. The fumes of arsine escaped from the opening and poisoned the nearest workmen. Five cases of severe poisoning with one death were caused in a New Jersey plant by the fumes rising from an uncovered tub containing hydrazobenzene made by this same method of alkaline reduction and evidently with arseniferous zinc. It was when the hydrochloric acid was added and the temperature raised to bring about the next stage, the molecular change of hydrazobenzene into benzidine, that the tub "boiled up," as the men said, and the five nearest it were overcome with the fumes — three very seriously, one fatally.

Dr. T. H. Wignall (12) of Manchester, who is connected with a large dye works, has made a very interesting study of the occurrence of arsenical hematuria in benzi-

dine makers and in workers in certain other reduction processes. His attention was called to the possibility of mild arsenical poisoning by a fatal case of jaundice in a benzidine worker, which did not come under his observation early enough to allow him to establish the presence of arsenic. He began then to have a quantitative test made for arsenic whenever the urine of an employee showed a color as deep as porter. When this occurred, not only was the urine of the man himself examined for arsenic but also specimens from all the other workers employed on the same process. The tests were carried out by Delépine of the Public Health Laboratory of Manchester. Wignall found that the tolerance to arsenic in cases of this sort was much greater than it is generally stated to be. Men whose urines are deeply colored, and contain albumin, blood pigment, and casts, may not consider themselves sick at all and may not even be jaundiced. Examination of those who do complain shows symptoms which might easily be attributed to aniline or to some similar compound. These symptoms are palor, slight icterus, rapid feeble pulse, languor, loss of appetite. Hospital treatment in Wignall's cases was always successful and there were no sequelae and no neuritis. It is evident that such cases might easily go unrecognized for years, especially as the absorption of arsenic would never be uninterrupted, and there would always be periods during which the air was uncontaminated and the man's system had time to rid itself of the absorbed arsenic. The histories of Wignall's cases show that in about four to eight weeks the arsenic has practically disappeared from the urine. The essential facts in his five cases are as follows:

Case 1. — Icterus, weakness; urine the color of dark porter, with methemoglobin and casts; 0.796 mg. arsenious acid per 100 c.c. urine on Nov. 14; on Dec. 12, less than 0.01 mg. and only a trace of albumin.

Case 2. — Porter colored urine with 0.035 mg. arsenious acid per 100 c.c. urine on Nov. 9; on Dec. 20, less than 0.01 mg.

Case 3. — Urine black, sp. gr. 1025, albumin; 0.2 mg. arsenious acid on Dec. 5; less than 0.01 mg. on Jan. 30.

Case 4. — Abdominal pain, vomiting, icterus; urine deep Burgundy red, clear, sp. gr. 1025, acid, much albumin, methemoglobin, and oxyhemoglobin; 0.185 mg. arsenious acid on Jan. 24; less than 0.01 mg. on Feb. 26.

Case 5. — No pain or icterus; urine dark brown, considerable amount of albumin, sp. gr. 1009; 0.07 mg. arsenious acid on Feb. 13; less than 0.01 on Feb. 27.

Cases of mild arsenical poisoning have developed in English plants, I am told, in cleaning out an aniline reducer, and in filtering off the zinc chloride from hydrazobenzene in benzidine production. The only cases on record in American dye works are the five given above. In our large dye works benzidine production is not attended with this risk, for the hydrazobenzene crystals are caught in a fine screen and the zinc dust filters through and is used again.

If one examines the histories of the German cases of aniline tumor in the light of this theory, that arseniuretted hydrogen may be the causative agent, not any aromatic compound, several features emerge that seem to strengthen it.

In the first place, all the products which have been held responsible for these tumors are reduction products, formed by nascent hydrogen acting on a nitro compound.* As we have seen above, such

* For beta-naphthylamine this is not true. It is made, not by a reduction process, but by treating beta-naphthol with ammonia water. The only explanation I can suggest for the occurrence of tumors in this department is one based on the conditions in the one American factory where I have seen it made. Here in the beta-naphthylamine department, naphthylamine-sulphonic acids are made by the reduction of nitronaphthalene-sulphonic acids, and the reducing agents used are scrap iron and chamber sulphuric acid. At the time of my visit, an escape of fumes directly after reduction was very evident. One would have to know just what processes were carried on in or near the beta-naphthylamine departments in the German factories where this has seemed the danger spot, before one could decide the question whether there was or was not a possible source of hydrogen arsenide fumes there.

reduction is carried on by means of hydrochloric acid or sulphuric acid with scrap iron or zinc dust exactly as if one were making Marsh's test for arsenic. The compounds produced by alkaline reduction with subsequent treatment of the zinc dust with hydrochloric acid seem to be more productive of bladder tumors than those produced by acid reduction, and we have seen that there is more danger of escape of hydrogen arsenide fumes in alkaline reduction than in acid reduction. The benzidine department is the one in which the largest number of cases are at present appearing. Nassauer attributed his entire twenty-eight cases to the fumes from benzidine manufacture. A significant case related by him is that of a woman — the wife of one of the workmen — who did not work in the plant but lived in a room next to the one in which benzidine was prepared. She and her husband both had tumor of the bladder. It is shown in the statistics from Hoechst and from Greppin that benzidine men have a shorter period of exposure before the development of tumors than do fuchsin men (6), and the one of Oppenheimer's cases that developed most rapidly was in a benzidine worker.

That long continued absorption of small quantities of arsenic may result in the formation of epithelial growths, benign and malignant, was established by Jonathan Hutchinson and confirmed by dermatologists in America, Germany, and France. In discussing the chemical bodies which have the property of stimulating new growth, Leuenberger places arsenic at the head of the list. Nutt, Beattie, and Pye-Smith (13) have recently collected such cases from the literature and have added another. Thirty-one cases make up their list, in three of which, however, the administration of arsenic was not proved. Two were industrial in origin; the men had been working for years in a factory making sheep-dip with white arsenic. Three were caused by drinking water contaminated with arsenic in the Reichenstein epidemic described by von Geyer before the International Congress of Medicine, Paris, 1900, and twenty-three were attributed to the action of repeated doses of arsenic administered as a medicine for many years, usually for some skin disease, but in three instances for constitutional disturbances. In one instance, the lesions developed some years after discontinuance of the arsenic. Dubreuilh in 1910 described four cases of arsenical keratoma, one of which underwent carcinomatous degeneration.

The Germans have commented frequently on the analogy between aniline tumors and those caused by soot, pitch, and paraffin. Leuenberger and Nassauer have already been quoted to this effect, and it is significant to note in this connection the findings of the British Royal Commission on Arsenical Poisoning, with regard to arsenic in coal. Delépine found by analysis 5.8 grains of arsenious acid, $As_2O_3$, per pound of coal in one specimen, and 28 grains in another. The epidemic of arsenical poisoning from beer in Halifax in 1902 was traced to drying the malt in air heated by burning coal which contained arsenic.

Even more significant is a recent study made in Belgium of briquette makers' cancer, which the authors attribute to arsenic present in the coal. Bayet and Slosse (14) found in one briquette factory three men with skin cancer out of a force of only thirteen men, and later two more cases developed. Inquiry revealed a history of warty growths in six more, so that eleven out of thirteen men had skin lesions. These were not typical keratomatous plaques on soles and palms, as described by Jonathan Hutchinson in arsenical cancer, but carcinomatous degeneration of warty growths. The likeness to arsenical cancer was seen, however, in the fact that the cancers were multiple and developed fairly

early in life. There was also an extraordinarily large number of scrotal lesions, as in chimney-sweeps' cancer. Except for soot cancers this is a very rare location, only one among 2,400 malignant tumors in males in the Vienna General Hospital occurring there. The final proof that arsenic was the cause of the lesions was furnished by the detection of arsenic not only in the coal, soot, dust, and briquette mixture, but in the urine, hair, and finger nails of the workmen. Control tests made in the villages among other workmen gave negative results. Bayet and Slosse would attribute also to arsenic in coal the English cases of chimney-sweeps' cancer and the epithelioma of English briquette makers.

Finally, an analogy has also been drawn between aniline tumors, caused apparently by some chemical irritant, and the lung carcinoma of cobalt arsenide ore miners. The occurrence of malignant lung tumors among the miners of the Schneeberger cobalt mines in Saxon Switzerland, which was brought to light as long ago as 1878, has not aroused as much curiosity among German pathologists as one would have expected. A tumor described by Härting and Hesse (15) in 1878 was examined by Weigert and pronounced by him to be lymphosarcoma, originating in the bronchial lymph glands. Härting and Hesse stated that 75 per cent. of the cobalt miners died of malignant lung tumor, and they believed the cause was the arsenic of the ore, which consists of cobalt arsenide, nickel, and bismuth. Nothing more seems to have been heard on the subject till 1884, when Ancke (16) reported a second case of lymphosarcoma of the lung. In 1913, Arnstein (17) reviewed the whole subject, and found that 44 per cent. of the deaths among Schneeberger miners were attributed by the physicians of the region to malignant tumor of the lungs, but that the diagnoses were not based on autopsy. He examined seventy miners and found physical signs of lung disease in about half; especially indicative of lung sarcoma was the parasternal and paravertebral dullness. He could secure material for only two autopsies, and one of these proved to be caseating tuberculosis, but the other was a malignant tumor — squamous celled carcinoma — originating in the right lung and with extension to pleura and pericardium, and with metastases resembling lymphosarcoma in lymph glands, liver, and spleen. He found that Schmorl of Dresden had had two cases of round-celled sarcoma of the lungs in Schneeberger miners in recent years, and one case of squamous celled carcinoma.

In view of the proof that chronic arsenical poisoning is capable of producing a continual irritation which gradually results in cell proliferation, benign or malignant, and since the possibility of hydrogen arsenide poisoning is admittedly present in all the processes with which the bladder tumors of aniline workers have been associated, it seems fair to insist that hydrogen arsenide is a possible cause which must be considered. There is no such proof of the power of amido compounds to cause tissue proliferation.

If this explanation is proved true by quantitative tests for arsenic in the urine of men employed in dangerous departments, it will greatly simplify the problem. Instead of a multitude of compounds any one or all of which may be the sought-for cause of bladder tumors we shall have one only, a compound not constantly present in any process with which these tumors have been connected, but probably present from time to time in every one of them. It will explain certain puzzling features of the problem; such, for instance, as the fact that it is only the production of aniline or benzidine that gives rise to tumors, not their subsequent use as intermediates. As Grandhomme pointed out in his controversy with Rehn, there is no reason why

aniline fumes should cause tumors in the men in the fuchsin department and not in the other 4,000 men exposed to aniline in the rest of the plant. It is also singular that, after years of extensive use of aniline in rubber compounding and in reclaiming rubber in Germany, bladder tumors have not appeared as an occupational disease among rubber workers.

It is quite true that no case of bladder tumor has so far been traced to slow absorption of arsenic. The cases of cancer following prolonged administration of arsenic have been in the skin. Whether the difference in the method of administration, by inhalation of minute quantities, instead of by ingestion, would account for the difference in location of the lesions can be only a matter of speculation, as is indeed this whole discussion. Nor is it a speculation to which American industrial physicians can contribute anything positive as yet, for the making of dyes and dye intermediates is too recent in this country to lead us to expect the appearance of bladder tumors among the workmen for some years, if indeed the excessive labor turnover in this industry does not serve to protect them against it altogether. For the final acceptance or rejection of this suggestion as to the etiology of bladder tumors in color workers we must look to the Germans.

## Summary

The case for hydrogen arsenide as the cause of bladder tumors in aniline dye workers may be summed up as follows.

1. The substances, with the exception of beta-naphthylamine, which have been connected with tumor formation are all reduction ($NH_2$) compounds, formed by reactions in which the accidental production of fumes of hydrogen arsenide is an ever-present possibility, and the processes in which this danger is greatest are those noted as responsible for large numbers of tumor cases. Even in the best constructed plants minute quantities of the gas may escape, especially in the course of filtration or of cleaning or flushing out the apparatus. It seems far more reasonable to attribute such a slow toxic action to small quantities of hydrogen arsenide than to high dilutions of aniline vapors or to benzidine dust.

2. No aromatic compound thus far studied has been indisputably proved as the cause even of the cystitis which precedes tumor formation, and none connected with clinical cases of bladder tumor has been shown to be capable of setting up proliferative growth.

3. Arsenic absorbed from the fumes produced by reduction processes is excreted by the kidneys, and has been recovered from the urine. Since, then, arsenic is known to be capable of exciting epithelial proliferation in other parts of the body, it seems possible that the same effect may be produced when it acts on the mucosa of the bladder.

4. The resemblance between arsenical cancer and aniline tumors becomes plain when we study the literature of arsenical cancer caused by long continued internal administration of small quantities of arsenic as medicine or in drinking water, or caused by arsenic in soot and pitch, or by arsenic in cobalt ores. In all these growths, as in aniline tumors of the bladder, there is a precancerous stage of irritation, of epithelial cell proliferation, then tumor formation, and then slow carcinomatous degeneration. The whole process takes years, but the age at which the cancers develop is earlier than the average age for ordinary cancers. The growths are likely to be multiple, and, in the case of the skin cancers caused by administration of arsenic, the cancer may appear some years after the drug has been discontinued. The same phenomena have all been noted in cases of aniline tumor of the bladder.

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# HEALTH IN MERCANTILE ESTABLISHMENTS
# III. COMMON SANITARY DEFECTS IN STORES*

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A RECENT hygienic survey by the author of a number of large stores has disclosed certain sanitary defects which influence the health and productiveness of the workers. This paper discusses briefly the most common of these defects and suggests remedies for them. In the investigation in question it was encouraging to find that several of the newer stores were almost perfect in mechanical construction and functioning and that some of the firms occupying old buildings had spared no expense in improving the health conditions of their plants. In many of the stores the managements had made intelligent provision for the comfort of their employees not only while at work but also when off duty at noon.

## Problems Affecting Health and Comfort of Workers

*Locker Rooms.* — Separate locker rooms for men and women, with convenient wash rooms and toilets, require considerable space and equipment. The most common as well as the most satisfactory arrangement is to have metal lockers set in rows on a concrete floor in a well-lighted and well-ventilated basement. In a large store the locker room usually requires an attendant to insure cleanliness, proper lighting, and ventilation, and to prevent abuses, such as the storage of perishable food, the strewing of waste, pilfering, and the loss of time from unnecessarily prolonged personal toilet. A careful inspection system is always necessary. Rigid rules should be made to prevent the insanitary practice of keeping clothing elsewhere in the store, especially if food is to be handled. To overcome the evil of storing perishable food in locker rooms an employees' bundle room should be provided.

*Lunch Rooms.* — The noon lunch, so important to the worker's health and vigor, is a problem which has been studied and solved by many stores. It is essential that hot, nutritious food in sufficient variety be supplied as nearly at cost as possible, and that this food be served in congenial surroundings, where there is opportunity for rest and recreation.

The employees' lunch rooms at present provided grade from the lunch room equipped with tables and chairs for the use of employees who bring their own food, to the modern cafeteria which is presided over by a trained dietitian, and which supplies an excellent variety of food at cost. In every store there are always some workers who must practise strict economy because of dependents at home, and who are consequently apt to be undernourished. It is to the interest of the store that these employees receive substantial luncheon. In some cases this situation has been met by providing at very low rates simple, substantial food, such as milk, cocoa, bread and butter. Education in regard to a balanced diet is much needed. The appeal to the individual may be made on the score of both health and economy.

*Recreation.* — Suitable recreation at the noon hour is second in importance only to nourishing food. Good music provides relaxation more quickly and for a larger group of people than any other single means. To some of the more youthful and

* Received for publication Dec. 2, 1920.

more energetic workers dancing is an enjoyable recreation: to others, who prefer to read, a store branch of the public library is very acceptable. To still others, in seasonable weather, a walk in the open air gives the needed noon recreation.

The matter of recreation outside of store hours is an important subject, although at first it may seem to be beyond the circle of store influence. Studies are available to show that many shop girls and other workers lack suitable opportunities for necessary recreation and that this lack of diversion not only influences markedly their productiveness but also may result in frequent change of occupation. The employment office may some day add to its blank another heading — namely, *Avocation*. On the answer to this question often depends the likelihood of stability; a good avocation favors a settled vocation. Already many stores have, unconsciously perhaps, recognized the importance of recreation outside of work hours and have organized clubs, athletic teams, bowling teams, and theatre parties. Some stores have vacation or rest houses, which serve as preventoria for those physically below normal, and as clubhouses for social week-end parties. Such adventures in friendship have proved acceptable and successful.

*Drinking Water.* — The individual drinking glass which frequently becomes a common drinking cup should be replaced by paper cups or bubble fountains. To be sanitary, however, a bubble fountain should be so arranged that the stream of water does not fall back on the source and that the lips do not touch the source.

*Washrooms and Toilets.* — White enamel paint is a great aid in insuring cleanliness in washrooms and toilets. The rooms should, moreover, be sufficiently well lighted to avoid the possibility of dirty corners and should be supplied with some sort of waste bucket, preferably with an automatic closing top. Some stores have found it necessary, especially in public toilets, to have fixtures which cannot be blocked by waste.

The matter of providing towels involves considerable expense and has not as yet been entirely solved. Paper towels are hygienic but not altogether satisfactory. Individual cloth towels are expensive to buy, require laundering and much handling, and are too often shared with others. From a sanitary standpoint the electric hot air drier, which is being tried in many stores, is very satisfactory. It can be installed for $98 and furnishes a hundred dries for 7 cents. No figures are available on repairs and upkeep. The chief objections to this machine are that it is noisy and generally requires from forty to fifty seconds to dry the hands thoroughly — about double the usual time with a cloth towel.

*Common Causes of Fatigue.* — For members of the clerical force, who usually sit all day at the same desk, working conditions should be made as favorable as possible to reduce fatigue. Offices should be well ventilated without noticeable draft, and should not be too warm. The best *temperature* for these rooms is 68°. Higher temperatures produce a gradual strain leading to fatigue and lower temperatures, especially below 65°, are apt to be uncomfortably cool.

The *lighting* is the next most important consideration. Daylight in sufficient quantity is, of course, the best. If artificial light is necessary, indirect or reflected light from a favorable ceiling or diffused light from ground glass or porcelain globes is very satisfactory. The individual adjustable shaded light is best adapted for certain kinds of close work. It should be so arranged that the light falls over the worker's left shoulder, and that no shadows are cast. Careful tests should be made to discover any defects in eyesight and to see that suitable glasses are worn to correct any errors that exist and to prevent eye-strain.

Even in the best equipped stores covered in the author's survey a lack of proper *seats* for clerks was noticeable. The chair, the desk, and the foot rest should be adjusted to the individual and to the work to be done. These factors have, perhaps, been most successfully worked out at the modern telephone switchboard. The best chair * available for individual adjustment is doubtless the typist's chair. It is essential, however, that the worker understand how to adjust it in order to secure proper support for his back. Often a stool or foot rest is necessary for a very short person.

In one store where adjustable chairs were provided, they were most unpopular among some of the workers simply because the girls did not understand how to adjust them. Another objection raised was the difficulty of revolving the chairs easily to consult files placed at one side. On the other hand, a number of the more intelligent clerks in this force expressed great satisfaction and said that since adjustable chairs had been given them they had ceased to experience fatigue of the back. It would be an admirable scheme if every new employee, whether a clerk or a worker in a repair room or workroom, had her eyesight and her posture determined and was then carefully fitted to her place by someone familiar with physical requirements. Such a system would prevent unnecessary fatigue and ill health.

As a further aid in preventing fatigue among sedentary workers mid-morning and mid-afternoon exercises in a well-aired room, under the leadership of a physical director, have proved to be worth while. They furnish relaxation, refresh the workers and lead to an increased output.

The telephone switchboard has been commended for the excellent mechanical adjustment of seating and foot rests. Here a modified light is used to aid in seeing the light signals. In some of the stores surveyed the ventilation for the telephone girls was poor owing to the fact that the switchboard had to be shut off by partitions on account of nearby noises. Telephone work has a certain fascination and requires dexterity, but it tends to keep up the nervous tension in an already high-tension type of person. To meet the danger of fatigue, therefore, frequent short rest periods are desirable. A comfortable lounging chair, with light suitable for reading, placed near the switchboard and used in turn, has in some instances proved more successful than a distant rest room.

The tube room or cash room, now fortunately becoming less common owing to the extended use of the cash register, has certain common dangers. It is often in the basement and consequently dependent on artificial light and air. It is apt to be noisy and sometimes overcrowded. The hazard of dirty money is also present. Convenient provision should be made for moistening the fingers for sorting bills, and warnings should be given never to use the mouth for this purpose. Workers in these places in particular should acquire the habit of washing their hands thoroughly before eating.

Women are becoming more and more awake to the comfort and pleasure of comfortable *shoes*. To a girl who must stand most of the day a suitable shoe is invaluable. A number of stores carry good looking sensible shoes in their shoe departments and, recognizing the importance to their sales force of wearing such shoes, have offered a substantial discount to employees. One buyer of shoes tells me that he carries a college girl's shoe, which he sells to school girls, who admire college girls. In such a way he is able to fit with suitable shoes many persons who otherwise would be guided entirely by fashion in purchasing.

No one type of shoe is suited to all varieties of feet. For example, the growing girl

* A work chair especially adapted for use at tables or desks will be described in a subsequent article in this JOURNAL. Enquire before replacing chairs.

and the heavy, middle-aged woman need quite different shoes. In the store survey it was found that some workers kept extra shoes in their lockers for store use, and changed from their street shoes every morning. This practice might be of great value if more generally adopted, for it would very naturally result in the common use of a suitable store shoe.

*Pin Ticket and String Cutter.* — Two sources of injury which are often responsible for infected wounds are commonly found in stores — namely, the pin ticket and the string cutter. Pin tickets are used for marking a few articles of clothing. Even if they are put in by machines, they may still be a source of injury to the salesclerk and to the customer. They are a not uncommon source of trouble to the worker who inserts them by hand. Some other device for marking articles should be substituted. The counter string cutter has a point sufficiently sharp to inflict wounds. It can be rounded or dulled to a safe shape without reducing its usefulness.

*Counter Wash Basins.* — As the selling of white gloves requires the salesgirl to wash her hands frequently, small wash basins are usually provided, often below the glove counter. A mild soap, preferably in the form of liquid or powder, should also be supplied. A cake used in common is less desirable. Sufficient towels are usually furnished. It is quite common in winter, however, to find that a salesgirl has chapped or dried hands, and cannot clean them easily. To prevent chapping a hand lotion should be provided in a form convenient for easy application after each drying.

*Sale of Food.* — The public sale of food in stores dealing primarily in clothing and general merchandise carries certain risks. In our survey the soda fountain and ice-cream counter in some instances were found to be controlled by firms outside the store management — an arrangement which is always attended by some risk. Some of the soda fountains investigated were found to be well run and reasonably sanitary; others could not be passed without considerable criticism. The public does not distinguish between managements, so criticisms must be borne by the store. Similar responsibility is reflected on the store in the case of the chiropody, the manicure, the optical, and the hair dressing departments.

If a store is selling food to the public, the food handler must be not only neat and scrupulously clean but should also have been declared free from communicable disease by the store health department. The garbage must be systematically cared for and frequently removed. Perishable foods, such as milk, must be carefully guarded. Ice cream may also be a danger if it is not properly protected. The handling of food and money by the same person, as commonly happens at candy counters, is not a safe procedure.

Customers' restaurants are found in a few stores but in general they have been given up. If the management decides that a customers' restaurant is desirable, it must be made a model of cleanliness and attractiveness in order to be successful. These restaurants, I am told, seldom pay profit equal to the value of the space which they occupy. For sanitary equipment, healthy personnel, and safe practice, considerable responsibility is assumed by the store, whether or not it assumes the financial risk. Failure to maintain a high standard reflects directly on the store.

### Conditions Affecting Both Workers and Customers

The customers, the buying public — largely women — are directly concerned with the conditions in stores. So far the questions considered are ones which principally affect the worker. The problems discussed below, however, concern equally the customer and the worker.

The location of the store is favorable according to the convenience of approach, the breadth of streets or open spaces around the store, the amount of sunlight and air, and the absence of noise, smoke, and dust nuisances. One store has an open canal at its rear, which in summer emits an odor sufficiently pungent to cause shoppers to sniff the air inquiringly. The answer received is "city politics."

*Overcrowding.* — The shopping public is often repelled by overcrowding, which is common on the street floor of department stores. To prevent this undesirable condition the entrances should be large and numerous and easy of access, the aisles should be broad and unobstructed, and adequate elevator service should be provided. Congestion may be somewhat relieved by removing to other parts of the store goods which are in considerable demand. The practice of allotting to departments space proportional to their earnings results, for example, in a whole floor being given to the furniture department in which may be found a half dozen shoppers, while the street floor is overcrowded with purchasers of small wares. The management alone can give due weight to the comfort and health of everyone by considering these factors in apportioning space.

*Elevator Service.* — Sufficient and convenient elevator service may create favorable contact with the public. Three stores in particular have strikingly capitalized this contact by the neatness and courtesy of their elevator operators and by the mechanical perfection of the service. The chief fault with the older type of elevator is that its entrance is so narrow that the time needed for filling and emptying is markedly lengthened. Thus, its convenience and efficiency in transportation are limited. The elevator about 10 feet wide by 6 feet deep, with doors folding in six sections, is the most efficient type which I have observed. To avoid confusion and loss of time one store has installed two banks of elevators in the center of the building — one side carrying passengers up, the other side bringing them down. At first thought this might seem inefficient. Careful observation has, however, proved this to be the more efficient service under the conditions found in this store. It took but a short time for the public to become accustomed to the system.

The natural tendency of the average elevator operator, like a street car conductor, is to order about the meek passengers. While safety may at times demand this, the American public naturally resents it. Courtesy here means much to the shopper who is often easily confused.

One store has successfully supplemented its inadequate elevator service by an escalator. Many people willingly walk down convenient stairways in preference to waiting for a crowded elevator.

*Ventilation.* — Under-ventilation is the common accompaniment of overcrowding, a discomfort to which many shoppers are very sensitive. Often a day's shopping is dreaded for this reason alone.

The basement store is particularly unpopular with some shoppers. This prejudice is often, but not always, justified. It is usually possible to supply sufficient artificial ventilation, except perhaps in rush times. The practical difficulty disclosed is the fact that the control of the ventilating system is in the hands of the engineer who has many other duties. Some effective check or follow-up system is needed to prevent under-ventilation. To avoid prejudice a basement store should, if possible, be over-ventilated. The practice which is now in use in many stores of running the ventilating system at night and sometimes over Sunday offers one solution of the ventilation problem. Fear of drafts results too often in under-ventilation which frequently increases the susceptibility to colds. However good the system

of ventilation may be, experience shows that a follow-up is necessary. Inspection should be systematized and made a regular duty if the problem is to be solved, and should, if possible, be superintended by someone with a medical point of view.

In large, crowded offices and workrooms, supplementary ventilation has been satisfactorily obtained by exhaust fans, placed in the upper sashes of the windows. Air ducts supplying fresh air are necessary in some offices where partitions have been carried to the ceiling in order to eliminate noise.

*Cleaning.* — A store cleaning system may perhaps be best judged by its results. A factor of special importance to the store health department is the health of the cleaning force who, being largely absent during store hours, may easily escape notice.

Vacuum cleaning is by far the most sanitary method of cleaning because dust and dirt are removed with no danger to the worker. The feather duster is at the other end of the scale of cleaning methods, and, like the common towel, to be suppressed, requires constant watchfulness. The oil dust cloth can often be substituted to do the same work.

Flooring is intimately connected with the cleaning job. A smooth surface with the fewest possible cracks is the best cleaning surface. Other factors besides cleaning must be considered in selecting flooring, such as appearance, cost, comfort and durability, including liability to injury from desk, chairs and truck wheels. From a health standpoint, comfort is a very important factor. Two kinds of floors cause discomfort to the salesperson, who must stand the greater part of the day: concrete or stone flooring is cold and hard; carpets, especially if they are soft and thick, are hot and tiring.

The flooring which best meets all the requirements is battleship linoleum. Especially does this meet the sanitary conditions of comfort and ease of cleaning. Cork, wood, tile and concrete are somewhat less favorable from a health standpoint. Carpets are often necessary and, if used, require thorough and frequent cleaning. The disadvantage of hardness in flooring may be partly compensated for by the use of matting and by the wearing of suitable shoes with rubber heels.

*Dust Hazards.* — Apart from the store cleaning system, dust hazards are sometimes found in certain store work, such as silver polishing, fur beating, upholstery workrooms and packing. The buffing and fur beating departments require exhausts to protect the employees. The use of paper or excelsior instead of hay does away with much of the dust in the packing and receiving of goods.

*Drafts.* — The entrance door problem of cold air and drafts during the winter has largely been solved by placing a generous heating surface either in the vestibule or just inside the revolving doors, thus heating the fresh air admitted with the customer. Glass shields are sometimes necessary to protect the worker and the goods on counters located nearby in the line of drafts.

## Importance of Proper Industrial Relations and Medical Service

A follow-up system is the key to success in all sanitary matters. Experience already shows that lack of such a system has defeated more carefully prepared plans than any other factor. The human element is commonly responsible for poor ventilation in the modern well-equipped store. The three departments which are directly interested in good store housekeeping are the management, the engineering department, and the health department, all of which should be represented in formulating instructions and in following them through to results.

Thus, industrial relations become prominent in successful sanitation. One of the most satisfactory store sanitary systems which has been worked out owes its success to the ready welcome of all suggestions or reports to the engineering department. The chief of this department considers that the education of all store workers to report trivial matters immediately and freely is the key to success in the functioning of his store housekeeping system. All reports receive cheerful and prompt attention, even though it is recognized that perhaps one in four or five such reports needs action.

Proper industrial relations of a store require due consideration when any new measure, such as visiting nursing, is introduced. Publicity within the store, to be successful, requires a well-thoughtout plan. It should first be explained and discussed at the committee meetings of the management and of the sub-management or heads of departments, and then should be brought to the attention of all the workers by means of bulletins, by notices in their pay envelopes, or by articles in the store paper. Misunderstandings will thus be prevented and criticisms may be made which will result in wise alterations in the original plan.

In following up the system of sanitation, the health department should be on the alert to detect illness arising as the possible result of failure in some sanitary feature.

Figure 1

HEALTH SERVICE DEPARTMENT

DAILY REPORT

*Date*

| Department | Male or Female | Employee | Customer | Name | Medical | Surgical | Industrial Accident | Complaint | Treatment | Disposition of Case Remarks | Rest Room | Home | Seen by M.D. | Seen by Nurse | Advice | Recalls | Floor Calls | Transportation |
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A daily record form (see Figure 1) has been worked out and tried with success in a number of stores. One line only is used for each case. The monthly report results from addition of the columns. From the monthly report an annual report can readily be made, which will show, among many things, where illness is most common, and will often reveal a preventable cause. Such a daily record will enable a store to compare the healthfulness of its employees with that of workers in other stores, and may thus constitute an added attraction for prospective employees.

In the store emergency room it is a common practice for the nurse to give

immediate relief. Such relief has only too often consisted in drugging; the pill has frequently become almost the sole reliance. Unless medicines are given in accordance with standing orders of the doctor, who thus carries the responsibility, the emergency room is not even within the legal limits of medical practice. It is a lost opportunity to do any lasting good for the individual patient and consequently for the future welfare of the store.

When patients come for relief, they wish to receive good medical advice, which results from an intelligent understanding of their physical condition, their personal hygienic habits, their work, and even their play. If the future health of the employee is of value to the store, it is a matter of economy to furnish high-grade medical service.

To help build up a healthy, stable, and reliable personnel is the principal object and the chief justification of store medical service. It is, therefore, recommended that the emergency room be developed into a store health department with all that this term implies. Those who recognize early the importance of sanitary factors and adequate medical service, and who build wisely should first reap the benefits.

# BOOK REVIEWS

**Hygiene of Communicable Diseases: A Handbook for Sanitarians, Medical Officers of the Army and Navy and General Practitioners.** By Francis M. Munson, M.D., Lieutenant, Medical Corps, U.S.N., Retired; Lecturer on Hygiene and Instructor in Military Surgery, School of Medicine, Georgetown University; Formerly Instructor in Medical Zoölogy, Georgetown College; Late Brigade Surgeon, and Provisional Brigade, U. S. Marines. Cloth. Pp. 793 with illustrations and index. New York: Paul B. Hoeber, 1920.

Dr. Munson has written a book which, in spite of the scope and rather minute detail, is still compact and physically manageable — an item of no small importance in the usefulness of a book. Due to the paragraph arrangement and an excellent index, the material is available for ready reference, so that the book should prove of value to all health officers, either civil or military, engaged in field work. It makes no pretence, I think, of being a laboratory manual, in which field its value would be much more questionable.

The author begins with a brief consideration of the various types of infecting agents and the theories of immunity. Chapters are devoted to such specific problems of sanitation as municipal, railway, military, prison, and school emergencies due to great disasters *i.e.*, floods, earthquakes, etc. Dr. Munson is perhaps at his best when dealing with military sanitation, where the wealth of detail as to delousing, the disposal of human and animal excreta under various conditions, disposal of sink water, etc., would be invaluable in planning and administering the sanitation of a camp.

In the second part of the book, the diseases are grouped according to their mode of spreading and are considered individually. Parts of some valuable documents are quoted at length, such as the Interstate Quarantine Regulations of the Treasury Department, and War Department Orders and Directions Regarding Venereal Prophylaxis. The consistent use both in title and text of the term "communicable" instead of "infectious" or "contagious" is gratifying.

In spite of the introductory remark that no statement is made which is not supported by competent authority, we find, to our surprise, the unqualified statement that the etiological agent of measles is a filterable virus, and the etiological agent of influenza, the B. Influenzae. True, we read further on that "the consensus of opinion is that the bacillus of Pfeiffer, Bacillus Influenzae, is the specific causative agent, but that most cases are mixed infections." Even this does not appreciably lessen the surprise. Then, over two pages are devoted to what reads like a modern fairy tale, under the heading *The Pandemic of Influenza of 1918–19*, which has to do with a theory that the influenza bacillus is metamorphosed from the plague bacillus, and that the whole miserable pandemic started in China as pneumonic plague, and thence was spread into Germany by Chinese coolies, and thence all over Europe and America as influenza.

In the chapter on *Venereal Diseases*, Dr. Munson deals largely with the military and naval aspects of the question. He feels that "a medical program for civil communities equivalent to the military program for prevention and treatment should be encouraged." In so far as the treatment is concerned, Dr. Munson's recommendation might well be adopted, but the prevention in the military sense means, besides education and the restriction of prostitution, alcoholism, etc., the prophylactic station. There lies the difficulty. I know that some, and I have been given to understand that practically all, of the states have found it impracticable for one reason or another to endorse the prophylactic station as a part of their venereal program. Theoretically, if such stations work in the army, they should at least be of some value in a civil campaign against venereal disease. Practically, it is not difficult to see the obstacles.

When considering the control of diphtheria in an institution, the author recommends the administration of antitoxin to all the inmates, repeated every ten days or two weeks as long as cases appear. No mention is here made of the use of the Schick test and toxin-antitoxin immunization of susceptibles. True, these procedures are elsewhere mentioned for control in military organizations, but it would certainly be a mistake in an institution to frustrate the value of a test like the Schick test by the wholesale administration of antitoxin.

Under the discussion on measles the author argues effectively against closing the schools in the presence of an epidemic. He also makes a plea for education against the exposing of young children. The not at all uncommon prac-

tice of exposing young children to measles to "get it over with" cannot be too severely condemned, when we consider that about 80 per cent. of the deaths from measles occur during the first three years of life, while in 1918 in Massachusetts only about 16 per cent. of all the cases of this disease occurred in this age group.

The author states that an attack of yaws confers immunity. There seems to be no reason to suppose that a person cured of yaws is any more immune to reinfection than is a person cured of syphilis. Immunity in syphilis is, to say the least, open to question. With the almost unquestioned short viability of the Treponema pertenue outside the body, there seems to be but little need for the thorough disinfection recommended to prevent the spread of yaws.

There are many good points made by Dr. Munson, such as the paucity of public comfort stations in American cities as compared with European cities; the danger from the broadcast distribution of raw human excreta along railways particularly when they border public or private water supplies; that the ordinary drip "disinfecting" machines in toilets and urinals are of service only in adding an unpleasant odor to those already present; that a "school without a playground is an educational deformity," etc. He gives regulations that should be in force in all barber shops. The average barber shop is certainly a sanitary nightmare. He also gives points of value in inspecting markets, abattoirs, etc., and many other suggestions which will, as has been said, be found of value to the health officer in the field. — *George H. Bigelow.*

**Organisation Industrielle, Médecine Sociale et Éducation Civique en Angleterre et aux États-Unis.** By René Sand, Inspecteur principal au Service médical du Travail; Agrégé de l'Université de Bruxelles; Membre correspondant de l'Académie royale de Médecine de Belgique; Médecin de régiment de réserve à l'Ambulance de l'Océan. Paper. Pp. 896 with index and table of contents. Paris: J.-B. Baillière et Fils, 1920; Brussels: Maurice Lamertin, 1920.

Dr. René Sand has recorded in this large book the impressions which he received during two visits to the United States and one to England in 1918 and 1919.

The title of the volume only suggests the multiplicity of subjects of which he writes. The Taylor system, industrial relations, industrial safety, the physiology of fatigue, child labor, unemployment, settlement houses, public health activities and social reconstruction — these and many other topics are discussed at length.

The work must be termed superficial — but that the author doubtless intended it should be. It is, however, in many instances very inexact, as any such record must naturally be, when its author is a kindly person *en tour* in a strange land and at the mercy of a multitude of individual enthusiasts all arrayed in their best official robes, each with his best foot forward. — *Wade Wright.*

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## THE PREGNANT WOMAN IN INDUSTRY*

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*Cincinnati, Ohio*

THE pregnant woman, her physician, and her employer, all have need of a better understanding of pregnancy in relation to work. The government, employers, and labor bodies are continually seeking to surround the woman worker with conditions that enhance her economic worth and are favorable to the maintenance of her health. These agencies have, however, failed properly to appreciate the fact that the normal pregnant woman is capable of work, and as a result have neglected the specific provisions that would make it possible and advantageous for her to continue at work.

In the industries of this country about five million women are employed, nearly one million of whom are married. An unknown but obviously large number of pregnancies occur every year among them. At this time of additional expenses preparatory to the child's birth and to after-care, an even greater necessity for earning money arises. Many times it is of mutual advantage to the employer and to the pregnant employee to allow her to continue her work as long as it is not harmful to her or to her unborn child. Through lack of dependable advice, it is the tendency of the expectant mother, especially the primipara, to discontinue work early in her pregnancy. She is influenced in her decision to do so by her apprehension lest in some way she harm her child; by gossip current among older women as to the disastrous effects of work; by her fear that in the plant she will become the butt of idle humor; by the fact that the mental and physical discomforts of pregnancy are at their height in this early period, thus leading her to think that she will continue to be too "miserable" to work. The employer, knowing little about the matter, "plays safe" and acquiesces in her decision, thus needlessly losing the services of a valuable worker.

There is great need of competent medical supervision by physicians who are not only well qualified as obstetricians but who are also well acquainted with trade processes, occupational hazards, fatigue and posture problems, chemical intoxications, and the like. Unfortunately, the physician serving this group of patients is very often wholly unacquainted with industrial medical matters and therefore incompetent to discriminate between suitable and unsuitable plant work. Too much is sacrificed, both by the woman and by the employer, through this lack of scientific knowledge as to the desirable work environment for the pregnant employee.

The approaches to the problem, which

* Received for publication Jan. 14, 1921.

TABLE 1.—MATERNITY BENEFITS

| Country or State | Date of Law in Force | Types of Benefit | | | | Source | Amount |
|---|---|---|---|---|---|---|---|
| | | Money in Lump Sum | Money in Instalments | Medical, Nursing, Institutional Care | Payment for Breast Feeding | | |
| Australia | 1912 | + | .. | .. | | government | $25 total |
| Austria | 1917 | .. | + | + | ½ amount for maternity benefit to end of 12th week | insurance premium — ⅓ employer, ⅔ employee | 60% of standard rate of wage class to which insured belongs |
| Denmark | 1915 | .. | + | if necessary | | insurance society; government | $0.27 daily |
| France | 1913 with subsequent amendments | to government employees only | + | .. | $2.70 at end of 4 weeks | government, mutual aid societies | $0.096 to $0.29 daily |
| Germany | 1911 | special wartime measure $5.95 | + | substitute for maternity benefit if desired | ½ cash benefit for 12 weeks; doubled for twins | insurance premium — ⅓ employer, ⅔ employee | $1.19 to $1.43 daily |
| Great Britain | 1912 | + | .. | cash benefit may be used in this way | | government insurance premium, employer and employee | $7.20 if woman is insured; $14.40 if husband is also insured |
| Italy | 1912—modified in 1917 | + | .. | .. | | insurance premium — ½ employer, ½ employee | $7.72 in two instalments |
| Luxemburg | 1902 | .. | + | .. | | insurance premium — ⅓ employer, ⅔ employee | cash benefit of ½ daily earnings |
| Netherlands | 1913 — not in effect on Jan. 1, 1918 | .. | + | + | | insurance premium — ½ employer, ½ employee | 70% of average wage until after childbirth; then 100% |
| New Zealand | 1911 | + | .. | + | | government insurance — ¼ government, ¾ insured | not more than $29.20 |
| Norway | 1915 | + | + | + | | insurance premium — 6/10 insured, 1/10 employer, 3/10 gov't | 60% of daily wage |
| Russia | 1913 | .. | + | + | | owners of establishments; insured; donations, fines, etc. | ½ to full wages |
| Sweden | 1913 | .. | + | .. | | government | $0.24 daily |
| Switzerland | 1914 | + | .. | + | $3.86 if mother has nursed child for 10 weeks | dues of members, subsidy of state | $3.86 lump sum |
| Colorado | 1913 | .. | .. | .. | | government | enough to care properly for child |
| Missouri | 1917 | .. | .. | .. | | government | one child, $16 monthly; $10 for each additional child |
| Pennsylvania | 1919 | .. | .. | .. | | government | one child, $20 monthly; $10 for each additional child |

TABLE 1. — MATERNITY BENEFITS

| Country or State | Time Limit | | Persons Included According to | | Remarks |
|---|---|---|---|---|---|
| | Before Confinement *Weeks* | After Confinement *Weeks* | Occupation | Wage Class | |
| Australia | | | unlimited except for natives and Asiatics | unlimited except for natives and Asiatics | medical certificate necessary to exclude stillbirths and abortions |
| Austria | | 6 | establishments using power or explosives, under industrial code, building trades, transportation | workers receiving less than $487 20 a year | present conditions unknown |
| Denmark | | 10 days, after which she is entitled to usual sick benefit | | workers without income-bearing property; over 15 years of age | only slight changes in law of 1892 because of "financial straits" |
| France | as indicated for mother, not more than 4 | 4 | all wage earners except rural workers | | 1917 law provides for wives of soldiers regardless of being wage earners |
| Germany | 2 | medical certificate required before return to work | all wage earners | others if income is less than $5 95 yearly | wartime measures providing special maternity benefits |
| Great Britain | | 4 | manual employment, non-manual if income is less than $776 64 | workers receiving less than $778 64 yearly | pregnancy benefit, British system most complex of all because of numerous perplexing features |
| Italy | | 4 | industries, factories, private telephone companies, government employees excluded | | nursing room for mothers in factory; no distinction between married and unmarried mothers |
| Luxemburg | | 4 | wage earners | salaried employees receiving less than $1.93 daily | |
| Netherlands | unlimited during entire period of disability | | regularly employed | to be specified later | no distinction between legitimate and illegitimate children |
| New Zealand | | | | all over 16 and under 45 years, receiving less than $1,000 yearly | maternity benefit a part of old age and invalidity insurance |
| Norway | 2 | 6 | all wage earners and salaried employees over 15 years | workers receiving less than $482 yearly | admirable provisions for illegitimate child |
| Russia | 2 | 4 | all wage earners in factories using mechanical or animal power | | requires owner to furnish hospital care; present conditions unknown |
| Sweden | | 2 | | | information incomplete |
| Switzerland | | 6 | all industries and occupations | | maternity benefits of this country have served as a model to many others |
| Colorado | | | mothers unable to care for children specified period, before and after childbirth | | mothers' pension fund |
| Missouri | 3 | 3 | unlimited | | mothers' pension fund |
| Pennsylvania | | | additional sum for unborn child if mother is already receiving pension | | mothers' pension fund |

have thus far been made, have been largely blanket provisions without consideration of the individual case with its specific problems of work environment, health, etc. The few measures in practice are chiefly the outcome of the activities of governments and labor bodies. In accepting some responsibility for the pregnant woman in industry, these agencies have adopted two general methods of procedure: (1) the prohibition of employment of women on any work during specified periods of gestation, the prohibition of employment of any women in certain trades, and the regulation of conditions of employment for women at work; (2) the provision of maternity benefits, thus making the necessity for work less frequent.

Although these existing measures are distinctly helpful, they are palpably inadequate. Obvious shortcomings arise from the failure to provide medical guidance throughout pregnancy and from the failure to determine more definitely the influence of specific work conditions upon maternity.

## Maternity Benefits and Legal Control of the Pregnant Woman's Work

Is the pregnant working woman jeopardizing her health by continuing work after the onset of pregnancy? Is the well-being of her child jeopardized by her working? When should the pregnant worker discontinue work? Are there certain occupations and types of work that are especially harmful? Is the fact that she is to give birth to a child of such economic importance that she is entitled to some form of compensation? In this country such questions have until recently occasioned no deep concern and only five states have laws definitely pertaining thereto. Fifteen other countries are far in advance of the United States — namely, Great Britain, France, Italy, Australia, New Zealand, Germany, Austria, Hungary, Denmark, Norway, Sweden, Roumania, Servia, Switzerland, and Russia.*

*Maternity Benefits* (1).—In most foreign countries, maternity benefits are included in systems of social insurance, are usually compulsory, and are designed to protect the health of the mother and child by providing moneys and medical and nursing care before, during, and after childbirth. By so doing, the financial burden of child-bearing is lessened and the mother is assured freedom from the necessity of excessive work for a reasonable period of time. These insurance systems usually consist in one of the following four types or in a combination of certain features of these types:

1. A fixed sum is paid at the birth of the child — the state supplying the funds.
2. Insurance systems to which the woman, her employer, and the government contribute.
3. The continuation by the employer of a portion of the wages of the woman — usually from 50 to 75 per cent.
4. The provision of medical and nursing care prior to, at, and after delivery.

Table 1 is a tabulation of the major provisions found in the maternity benefit system in force in various countries, and in a few states within the United States. In the countries indicated in this table, particular features in the treatment of the problem are noteworthy. In a few of the countries, the maternity bonus is available to every mother irrespective of her economic status. In others, only urban workers participate in the provisions on a compulsory basis. In certain countries the type of work or the amount of the wage limits the persons who are included. The unmarried mother is excluded from all benefits in a high percentage of the national laws. In some instances, race prejudices lead to the exclusion of mothers of designated nationalities. During the war some countries extended their

* Conditions in certain of these countries may have disrupted the application of existing maternity benefit measures.

TABLE 2. — LAWS PROHIBITING EMPLOYMENT OF PREGNANT WOMEN

| State or Country [1] | Date | Industries Included | Time Limit: Before Confinement *Weeks* | Time Limit: After Confinement *Weeks* |
|---|---|---|---|---|
| Vermont | | mill, cannery, workshop, factory, manufacturing or mechanical establishment | 2 | 4 |
| Connecticut | 1913 | factory, mercantile establishment, mill or workshop | 4 | 4 |
| Massachusetts | 1911 | mercantile, manufacturing or mechanical establishment | 2 | 4 |
| New York | 1912 | factory, mercantile establishment, mill or workshop | no provision | 4 |
| Austria | 1917 | establishment using power or explosives, building trades, establishments in industrial code, transportation | | 6 |
| Denmark [2] | 1901 | any factory work | | 4 |
| France | 1913 | industrial or commercial undertaking | | 4 |
| Great Britain | 1911 | remunerative employment | | 4 |
| Germany [3] | 1908 | | 2 | 6 |
| Italy | 1907 | factories, agriculture, etc. | | 4 |
| Norway | 1915 | industrial establishments | 4 (must be permitted to stop work) | 6 |
| Sweden | 1891 | industrial establishments | | 4 [2] |
| Switzerland | 1877 | industrial establishments | 2 | 4 |

[1] According to unauthentic information the state of Washington prohibits the employment of women 2 months before and 6 weeks after confinement.

[2] Unless she has doctor's certificate.

[3] Medical certificate required at end of 6 weeks.

provisions so as to encourage child-bearing and to relieve the wives of soldiers and government employees.

*Restrictive Measures.* — Practically all industrial countries have promulgated laws forbidding the employment of women in various hazardous trades and restricting the hours and time of work. These laws, although not primarily designed as protective of the pregnant woman, are distinctly beneficial to maternity. In addition, a limited number of states and countries have devised laws applying peculiarly to the pregnant woman. Switzerland was the leader in legislation of this kind. In 1877, the National Council prohibited the employment of pregnant women in industrial plants for a period of eight weeks, a part of which was prior to and the rest subsequent to delivery. The essential features of this type of legislation in various countries are grouped in Table 2.

At the time of the International Labor Conference held in Washington, D. C.,

November, 1919, the following draft convention with reference to the pregnant working woman was adopted:

Art. 3. — In any public or private industrial or commercial undertaking, or in any branch thereof, other than an undertaking in which only members of the same family are employed, a woman

(*a*) Shall not be permitted to work during the six weeks following confinement.

(*b*) Shall have the right to leave her work if she produces a medical certificate stating that her confinement will probably take place within six weeks.

(*c*) Shall, while she is absent from her work in pursuance of paragraphs (*a*) and (*b*), be paid benefits sufficient for the full and healthy maintenance of herself and her child, provided either out of public funds or by means of a system of insurance, the exact amount of which shall be determined by the competent authority in each country, and as an additional benefit shall be entitled to free attendance by a doctor or certified midwife. No mistake of the medical advisor in estimating the date of confinement shall preclude a woman from receiving these benefits from the date of the medical certificate up to the date on which the confinement actually takes place.

(*d*) Shall in any case, if she is nursing her child, be allowed half an hour twice a day during hours for this purpose.

Art. 4. — Where a woman is absent from her work in accordance with paragraphs (*a*) and (*b*) of Article 3 of this convention, or remains absent from her work for a longer period as a result of illness medically certified to arise out of pregnancy or confinement and rendering her unfit for work, it shall not be lawful, until her absence shall have exceeded a maximum period to be fixed by the competent authority in each country, for her employer to give her notice of dismissal during such absence, nor to give her notice of dismissal at such a time that the notice would expire during such absence.

The shortcomings of all such measures lie in (1) the scant provision made for the supervision of the health of the pregnant woman throughout the gestation period; and (2) the lack of investigation seeking to determine the effects of specific trades and occupations upon maternity.

## Hygiene of the Pregnant Woman

The pregnant woman is admittedly better off in a normal home environment than at work in a factory. With the proper guidance and supervision, however, it will not be harmful for the pregnant woman to work if work is an economic necessity for her. For those who must work, then, better health supervision and general guidance must be evolved.

*Is Work Harmful?* — There are many opinions as to the harmfulness of work for the pregnant woman. Many years ago, Jones(2) stated that "the pregnant woman should not be employed in industrial occupations." More recent opinions hold that work of the proper sort is definitely good for the normal pregnant woman. All books on obstetrics and all directions for the hygiene of the pregnant woman recommend mild exercise and fresh air. Industrial work may meet all these requirements. For instance, Paradise (3) states that "ordinary housework and many of the chores on a farm afford mothers the opportunity for necessary exercise." This is, of course, not factory work but there is much factory work less arduous than these domestic duties. In the usual factory there are many occupations which are less harmful than some housework; at the same time, it is true that there are many processes not at all suited to the pregnant worker. On the whole, we can accept the principle laid down by De Lee (4): "In a general way the gravida should not change her usual mode of life unless the physician knows that some of her habits are bad."

*Medical Examination.* — All these opinions apply to the normal pregnant woman. The crux of the situation, then, is to determine whether the pregnant woman is normal and to keep a close watch over her, so that her work may be regulated to suit her limitations. If proper industrial medical service is maintained, she should be encouraged to consult the doctor as soon as pregnancy is suspected. If the doctor confirms her suspicion, a thorough examination should then be made. The industrial physician is usually not competent to carry

out a satisfactory obstetrical examination, nor is the average practitioner so qualified. Upon detection of pregnancy, therefore, the worker should be referred to a suitable clinic or to an obstetrician. It is unnecessary to describe here the nature of the examinations which should be made. After the initial examination, however, subsequent examinations should be made when recommended by the obstetrician. At the very least, a complete examination should be made during the eighth month of pregnancy.

Although the industrial physician may not be qualified to make specific obstetrical examinations, there are many other requirements for the general health of the pregnant woman which he can fulfil. For instance, one obstetrician emphasizes the necessity of watching the teeth and bony structures which are likely to be affected because of the alteration of the phosphates of these tissues.

Full co-operation should exist between the plant physician or employment manager and the specialist. In this way only can the obstetrician know of the nature of the woman's work and thus be guided in his recommendations to the plant physician or employment manager. A great responsibility rests with the plant physician in his having a complete knowledge of trade processes, occupational and safety hazards, and suitable replacement jobs when they are necessary. Constant supervision should be exercised throughout by the plant physician. In a particular munition factory in England during the war, the women received very careful supervision and a definite routine was adopted. Upon notification of pregnancy the women were given suitable work, and as pregnancy progressed they were changed from time to time to work that was even better adapted to their needs. At the end of the seventh month, the pregnant woman was transferred to a particular room known as "the general clothing store and sewing depot." While she was at work in this room she was visited every week by a physician who examined a specimen of the urine and made other examinations. The work was so arranged that the women could remain at work until just before parturition, without harm to themselves or to the work (5).

*Accident Risk.* — By means of such careful supervision, the risk which an employer assumes in keeping a pregnant woman in his employ is reduced to a minimum. No statistics are obtainable as to the frequency of accidents among pregnant industrial workers. A knowledge of the physical alteration and the mental preoccupation of the pregnant woman, however, makes tenable the assertion that she is much more liable to industrial accident than the non-pregnant worker. Late in pregnancy locomotion is hampered through the changed posture made necessary by her adjustment to her shifted center of gravity. This leaning backward not only alters locomotion but is likely to prevent her from seeing where she is stepping. Since accidents growing out of such circumstances commonly occur to the pregnant woman in her home, we may expect such mishaps as falling over obstructions in passageways and downstairs to be no less common in the factory. Accidents of this kind frequently result in miscarriage. Consequently, the employer is incurring some liability in retaining in his employ women in an advanced stage of pregnancy.

Abortion and miscarriage, it must be remembered, are more frequent during the early stage of pregnancy and are due most often to causes in no way connected with the work environment. In one factory where a study of pregnant women was made, among 101 pregnant women in nine months, there were fifteen miscarriages, thirteen of which were abortions occurring between the fifth and tenth weeks. Of the two miscarriages, one was caused by an operation for carcinoma of the cervix, and the other was due to syphilis contracted

during the sixth month of pregnancy. Of the thirteen abortions, one fell out of bed, one fell downstairs (the report does not state whether at home or in the factory), one had tuberculosis, and one had had previous miscarriages. There are no facts as to the etiology of the other nine, but from these six it is apparent that the greater risk arises before the employer has been notified—that is, before pregnancy is definitely established.

As is well known, carelessness is the great cause of accidents. Continual vigilance on the part of all workers is the best safety device. In the case of the pregnant worker, a concentration on her immediate work and its hazard is more difficult, because she is continually mulling over her abnormal relations with other people and the circumstances attending her pregnancy and anticipated confinement. The recognition of the fact that the pregnant woman is an increased accident risk should not lead to her elimination from the plant but rather to her placement in non-hazardous occupations and to additional education in precautionary measures.

*Harmful Occupations.* — Throughout the discussion of what work is injurious to the pregnant woman, it must be remembered that any conditions which are bad for the normal woman worker are even worse for the pregnant worker. This statement applies to the hours of employment as well as to general working conditions. If the work is wearing and the normal woman finds eight hours of work a strain, the pregnant woman should not be forced or allowed to work so long. The pregnant woman should never be allowed on a night shift. Night work generally means that the woman has so much to do at home in the daytime that she cannot go out to work. The pregnant woman cannot stand the strain of day work and night work in addition. There may even be certain times of the day when the pregnant woman cannot work because of her condition. For instance, if she suffers from morning nausea, she should be allowed to remain at home until such time in the day as she is able to take up her work.

A knowledge of what constitutes harmful conditions must be based on the individual case, that is, the woman and her particular job. There are, however, some general principles which can help the physician in determining suitable and unsuitable jobs for the pregnant woman.

*Character of Work.* — Generally speaking, any undue physical strain is bad for the pregnant woman. De Lee states that "jolts, running, sudden motions, lifting great weights, going up and down stairs quickly, etc., should be avoided." Dorland (6) states that "lifting of heavy weights, running upstairs and other violent forms of exercise must be strictly avoided lest miscarriage result." In an article in the *Monthly Labor Review* (7), there are reported five types of occupation which are harmful: (*a*) Continuous sitting has a bad effect at delivery as well as on the mother's health after confinement; (*b*) standing continuously is less harmful except that it tends to induce varicose veins; (*c*) lifting, reaching, and stretching up are universally bad during pregnancy; (*d*) jolting is bad, and also (*e*) work to which muscles are not accustomed.

TABLE 3. — TYPES OF OCCUPATION SHOWING TENDENCY TO PRODUCE BAD RESULTS AT PREGNANCY

| Type of Occupation | Number of Women Employed during Pregnancy | Bad Cases | |
|---|---|---|---|
| | | Number | Per Cent. |
| Active | 213 | 83 | 39.0 |
| Sitting | 88 | 23 | 26.1 |
| Standing | 30 | 2 | 6.0 |

In Table 3 figures are given which bear out this statement of the evil effects of active occupations, sitting occupations, and standing occupations on the pregnant woman. Bad cases are those which had difficulty in some form or other before or at

the time of confinement. What the active occupations comprise is not stated but it may be assumed that lifting, reaching, and jolting are included. The percentage of bad cases is remarkably high in this group and, indeed, is very little lower in the sitting occupations. Although the figures show the standing occupations to be far less harmful than the other types of work, it must be remembered that only thirty women are considered — almost too low a number to be decisive. In a report on the *Proposed Employment of Women during the War in Industries of Niagara Falls* (8) certain conditions of work were specified which were more harmful to women, particularly in regard to their child-bearing function, than to men. Once again reference is made to lifting heavy weights, unusual stretching or straining, but more especially to continuous standing, as bad for women because of the difference in their body structure, in other words, the structure of their reproductive organs. If continuous standing is noticeably harmful for women in general on this account, how much more harmful is it for pregnant women in particular, who have an additional strain on these organs. Indeed, there can be no question that continuous standing is as harmful for pregnant women as any other of the specified forms of physical exertion.

The character of the work may involve a nervous strain as well as a physical strain. The mental attitude of the pregnant woman which causes her distraction, referred to above, is due to the fact that her whole nervous system is abnormal. She is morbid, sensitive, and at times hysterical. For this reason any undue strain on her nervous system is felt more than if she were normal. Monotony, speeding up, noise, vibration, a high degree of concentration, all cause a strain on the nervous system of the pregnant woman, which ought to be avoided.

*Analysis of Work.* — Keeping these general principles in mind, the industrial physician or the employment manager must set about analyzing his particular industry. He should examine each process at which women are employed, with a view to determining whether the worker is subjected to any of the strains enumerated above.

Specific recommendations in regard to occupations to be avoided by women were made in the survey of work at Niagara Falls. The Woman in Industry Service of the Department of Labor demanded the prohibition of the employment of women in (*a*) shoveling or wheel barrow work, (*b*) yard work, (*c*) loading or unloading freight cars, (*d*) lifting weights over 25 pounds. The first three types of work are obviously harmful but they serve to show a specific analysis of an industry. The fourth is of especial interest because it established a maximum lifting weight. The permitted weight is probably excessive and admittedly applies only to some women, and must be only an occasional process, not a continuous one. The recommendations of the Woman in Industry Service were made with reference to all women but they may be used as a gauge in the case of the pregnant woman.

Of more definite value in this regard is the survey of the textile industry (9). It was found that the mortality rate from puerperal infections and childbirth is higher in textile towns than in non-textile towns where there are not nearly so many married women employed. The U. S. Bureau of Labor Statistics made an investigation of preventable deaths in the cotton manufacturing industry, process by process. In the card room the work involves lifting bobbins weighing from 2 to 4 pounds each, and placing them on frames 5 to 6 feet high. This involves lifting and stretching — two of the physical strains to be avoided. The effect which this work has upon the married woman and consequently upon the pregnant woman is very evident when the statistics of deaths from various causes ac-

cording to conjugal state are examined. The deaths from tuberculosis among unmarried card room workers exceeded those of unmarried non-operatives by 93 per cent.; the deaths of married card room workers exceeded those of married non-operatives by 323 per cent. The deaths of unmarried operatives from non-tuberculous causes exceeded those of married non-operatives by 81 per cent. The report states that the high death rate of married operatives is influenced by the continued lifting of bobbins and placing them on frames above their heads. This process "may quite probably constitute a contributory cause of death from prematurely terminated pregnancy and from childbirth." In the spinning room, where the work demands constant walking or standing in a hot, moist atmosphere, the percentage of deaths of married operatives between the ages of 15 and 44 years from causes other than tuberculosis — parturition fatalities — is highest. The deaths from parturition number twenty-eight for operatives in this department as against five for non-operatives; or the death rate per 1,000 from this cause is 4.72 for operatives as against 0.53 for non-operatives. In the weave room, where the women do much bending over looms and generally carry the cloth weighing from 15 to 18 pounds to the scales, the death rate among the married women is very high.

In Table 4 the excess of deaths among married operatives over those among married non-operatives is appalling. The report throws some light on the cause of this excess in the following statement: "It will readily be appreciated how much fatigue such lifting (15–18 pounds) induces and how great is the danger to the expectant mother, especially during the last half of her pregnancy." In the spooler room the physical strain resembles that of the weave room. There is a great excess of deaths of married women over those of single women, due almost entirely to parturition fatalities. The deaths among married operatives exceed those of married non-operatives from non-tuberculous causes.

The number of deaths among married women operatives in each room was shown to be markedly higher than that of either single women operatives or married non-operatives. The deaths from parturition causes followed this general trend without exception. Further figures for the cotton industry as a whole show that many deaths which were classified as "Tuberculous" were "Parturition Complicated." (See Table 5.) The character of the work, as it is described, can without doubt be held responsible for this high mortality. Figures for the industry as a whole showing the deaths from parturition for operatives and non-operatives bear out this conclusion. Between the ages of 15 and 24 the death hazard complicated with parturition is seven times as great for operatives as for non-operatives; between the ages of 25 and 34, the death hazard is three times as great; and between the ages of 35 and 44, the death

TABLE 4. — PERCENTAGE BY WHICH DEATH RATES OF FEMALE WEAVERS EXCEEDED (+) OR FELL BELOW (−) RATES FOR FEMALE NON-OPERATIVES

| Conjugal State | Cause of Death | |
|---|---|---|
| | Tuberculous | Non-Tuberculous |
| Single | − 5 | + 7 |
| Married | +226 | +160 |

TABLE 5. — TUBERCULOUS DEATHS AND DEATH RATES PER 1,000 AMONG MARRIED FEMALES (15–44 YEARS) BY CAUSE AND OCCUPATIONAL GROUP

| Occupational Group | Number of Deaths | | | | Death Rate per 1,000 | | |
|---|---|---|---|---|---|---|---|
| | Not Parturition Complicated | Parturition Complicated | | Total | Not Parturition Complicated | Parturition Complicated | Total |
| | | Number | Per Cent. | | | | |
| Operatives | 88 | 37 | 30 | 125 | 3.56 | 2.0 | 5.56 |
| Non-operatives | 77 | 19 | 20 | 96 | 1.06 | 0.36 | 1.42 |

hazard is equal. The conclusion of the whole report is that "employment in cotton mills for mothers of child-bearing age is generally inimical to longevity of mothers."

It must be remembered that this report contemplates only the *deaths* in the cotton industry. How many women and how many children have been definitely harmed but not killed by the employment of women during pregnancy was not investigated. This survey should stimulate additional inquiries into the cotton industry and into every other industry employing women, with a view to bringing to light similar race hazards.

The general conditions in industry, which we have discussed, do not constitute the only hazards to the pregnant woman. There are many industries which utilize substances which in themselves are harmful. These substances are commonly classed as harmful to women in general and are, therefore, more especially injurious to the pregnant woman. On this account, many of the following occupations are prohibited to women (10) both in this country and in certain foreign countries: (1) the making of electric accumulators; (2) manufacture of paints, varnishes, and colors; (3) brass casting, zinc and lead smelting; (4) certain processes of glass manufacturing; (5) the manufacture of high explosives (previous to the war); (6) the curing and tanning of skins and hides. In France, lace-bleaching with white lead, sharpening or polishing of metals, and coating mirrors with quicksilver are among the many occupations prohibited. All the countries prohibit the employment of women in any lead industry. The majority of occupations forbidden to women involve the presence of dust, fumes, vapors, gases or substances of a poisonous character. There are many more industries which could properly be included in this list, especially when they are considered specifically with regard to the pregnant woman; *i. e.*, such industries as the manufacture of cordage and twine, enameling, the rubber industry, and pearl button manufacture.

In a series of articles, Dr. Alice Hamilton (11) has described the occupational effects of many chemicals used in industry. There are many which are especially harmful to the pregnant woman, such as benzene, used principally in the manufacture of rubber, in paint and varnish removers, in making aniline dyes; nitrobenzene, used in cleaning establishments; aniline, employed in the manufacture of dyes, rubber, and black paints, and in printing trades, etc.; arsenic, used in a large number of industries, such as in the manufacture of insecticides. Any substance affecting the kidneys is particularly dangerous for the pregnant woman because of the already overburdened renal functions at this time. The poisoning which results from the use of mercury, in processes such as silvering of mirrors, making of incandescent lamps, and felt hat manufacture, is especially prone to affect the pregnant woman. Carbon monoxide poisoning, which is one of the most commonly encountered industrial intoxications, is a hazard in many laundries, in tailoring trades and in bakeries, where gas burners are used. When this gas is inhaled in only moderately large quantities it has distinctly deleterious effects both on the normal and the gravid woman.

The lead industry seems to be the most hazardous industry for the pregnant woman. Lead poisoning takes many forms, for women its most disastrous effect being on the generative organs. In her report on *Women in the Lead Industries* (12), Dr. Alice Hamilton states that "women who suffer from lead poisoning are more likely to be sterile or to have miscarriages and stillbirths than are women not exposed to lead. If they bear living children, these are more likely to die during the first year of life than are the children of women who have never been exposed to lead. This

means that lead is a race poison." Dr. Hamilton cites the following statistics from the report of the British factory inspector for 1897 as striking proof of this fact: Out of 62 women who were pregnant, 15 never bore a living child. There were 212 pregnancies among these 62 women, but only 61 living children resulted; the stillbirths numbered 21; the miscarriages, 90. There are many available proofs of the danger to pregnant women from employment in occupations that bring them in contact with lead, and many obscure instances of lead poisoning in addition to the well-known cases. For instance, commercial artists or retouchers use a great deal of white lead, thinking that it is zinc. Lithotransfer work consists of preparing transfer papers with lead colors. There are many more such industries where lead poisoning is common, though seldom recognized.


### Summary

1. The pregnant woman is better off in the normal home environment than at work in a factory.

2. With proper supervision, however, it will not be harmful for the normal pregnant woman to work, if work is an economic necessity for her.

3. All pregnant working women should receive careful medical and vocational supervision.

4. The abnormal pregnant woman should discontinue work, and should resume it only on the advice of a competent physician.

5. The pregnant woman is an increased accident risk for the manufacturer. By means of careful supervision, however, this risk may be reduced to a minimum.

6. Any occupation that is harmful to the general woman worker is of greater harm to the pregnant worker.

7. The following types of occupations are harmful: (*a*) continuous sitting; (*b*) continuous standing; (*c*) repeated lifting, reaching, stretching; (*d*) jolting; (*e*) any work requiring new muscle adaptations.

8. Certain specific occupations are distinctly harmful to pregnancy and to childbearing functions. Lead trades constitute the outstanding example of this group.


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# A METHOD FOR DETERMINING THE FINER DUST PARTICLES IN AIR *

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IT is well known that a suspension may be removed from air by bringing the air in contact with water. The more intimate and prolonged the contact, the more efficient will be the removal. One of the simplest means of effecting such an intimate mixture, for purposes of dust analysis, is to introduce a small volume of air into a syringe containing some water. The syringe may then be shaken vigorously and a very thorough mixture of air and water accomplished. If a drop of the water be examined with the microscope by ordinary illumination, very few particles, if any, will be seen; by oblique illumination, however, the minute matter scintillates in the field and may readily be counted. This constitutes, in brief, the principles of the method presented in this paper, a method that is concerned chiefly with the minute particles.

In E. V. Hill's method (1) the air is drawn through the narrow nozzle of a capsule attached to a metal syringe; whereupon some of the particles impinge upon a small glass slip covered with a thin layer of a transparent adhesive mixture. A variable percentage of particles is actually caught, owing partly to the fact that the particles differ in inertia. The greater the inertia, the greater the likelihood of their being directed against the adhesive surface. Because of this property of inertia, the rate with which the piston of the syringe is withdrawn will influence the result. The count is made with ordinary illumination.

Palmer's method (2) consists in the filtration of air by means of the water-spray; but here again the removal is far from complete. Katz, Longfellow, and Fieldner (3) find that the Palmer apparatus retains about 45 per cent. by weight of air-floated silica and 13 per cent. of tobacco smoke as measured by the Tyndall effect. The air passing at the rate of 4 cubic feet per minute is in contact with the water but a very short time.

Aitken devised a method for the estimation of atmospheric dust (4) based on the principle that the dust particles serve as nuclei for the condensation of water-vapor. In this case all particles, even the minutest or those of an ionic nature, are included in the precipitation and share in the count. The watery envelope makes any determination of size difficult. The coalescence and evaporation of droplets may easily give rise to erroneous counts. It is a method requiring extraordinary care and skill.

Bill's electric precipitation method (5) is in process of development. The removal of dust particles appeared to be greater than in Palmer's method but in its present form it is unsuitable for field work. In this method, as in Aitken's, all particles of whatever size tend to undergo precipitation. The determination is gravimetric.

## Procedure

A Luer syringe graduated to 100 c. c. but having a capacity of about 160 c. c. is thoroughly cleaned with soap and water and alcohol to remove all grease. It is then rinsed with freshly distilled water and filled with distilled water free from air bubbles. After forcing out all the water, 20 c. c. of distilled water are taken into the syringe from an Erlenmeyer flask provided with a cotton-wool filter (Figure 1). The syringe is now ready for the air sample. The piston is withdrawn sufficiently to admit approximately 100 c. c. The exact volume may be read from the graduation. While placing the finger tightly against the nozzle, a piece of rubber membrane intervening, the syringe is shaken vigorously for one minute with an up and down motion. With the syringe in a vertical position the water is brought up to the very tip of the nozzle and then withdrawn slightly to

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admit a small bubble of air. This manipulation is intended to catch the particles adherent in the narrow portion of the nozzle and bring them into suspension.

The next step consists in allowing a drop to flow from the syringe into the chamber

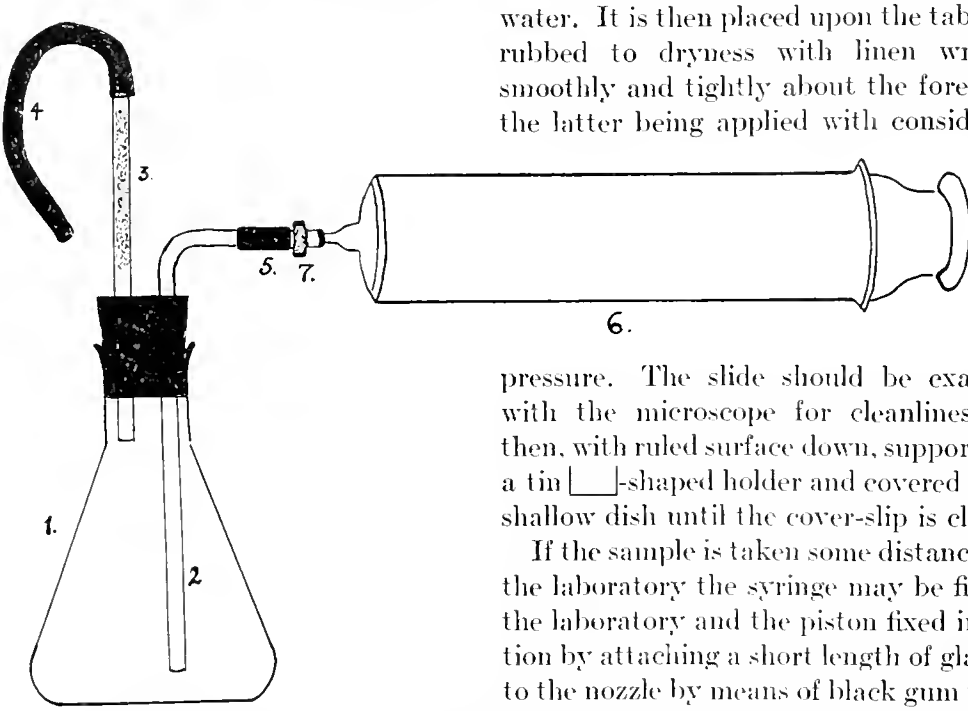


FIG. 1. — 1. Erlenmeyer flask. 2. Glass tube. 3. Glass tube containing cotton-wool. 4. Rubber tubing. 5. Pure gum connecting piece. 6. Luer syringe. 7. Metallic connecting piece.

of a Levy blood counter. This is best done with the metal connecting piece on the nozzle. The particles are counted by oblique illumination. The results reported in this paper were obtained with the No. 3 objective of a Leitz microscope with a circular piece of blue glass below the Abbe condenser. A 75-watt Mazda daylight lamp was placed in front of the mirror, a jar of water intervening to absorb the heat rays. Both lamp and jar were covered with an asbestos hood.

It will require patient practice in the beginning to free the ruled surface and cover of the Levy chamber of dust particles. A surface sufficiently clean for ordinary illumination will not do at all for oblique illumination. It is well to have on hand several handkerchiefs of pure linen that have been washed several times. Lens paper is useless. The ruled surface is thoroughly rubbed with the thumb, under a tap of warm water, and finally rinsed for a moment in hot water. It is then placed upon the table and rubbed to dryness with linen wrapped smoothly and tightly about the forefinger, the latter being applied with considerable pressure. The slide should be examined with the microscope for cleanliness and then, with ruled surface down, supported on a tin ⊔-shaped holder and covered with a shallow dish until the cover-slip is cleaned.

If the sample is taken some distance from the laboratory the syringe may be filled in the laboratory and the piston fixed in position by attaching a short length of glass rod to the nozzle by means of black gum tubing free from powder. After the sample has been taken, it remains in the syringe with the piston fixed. This permits another thorough mixture on reaching the laboratory. The entire number of particles in two fields, each a square millimeter, are counted. The average of these two counts is used in the calculation. Those fields are selected which are divided into sixteen smaller areas, each a sixteenth of a square millimeter. The particles must be allowed to settle before the count is made.

### A Modification of the Foregoing Procedure

A few determinations have been made with a modification of the above method, somewhat more complicated, but based on exactly the same principle. In this paper the steps will be merely indicated.

A test tube of 150 c. c. capacity, provided with a glass stopper perforated by two glass tubes, one of which extends to the bottom, is filled with distilled water. A filter (Figure 2) is connected with the short tube. The syringe being attached to the long tube, the contents of the test tube are emptied to the 30 c. c. mark. The test tube now contains filtered air and 30 c. c. of distilled water. An air sample may be taken by removing the filter and connecting the short tube with the syringe. After vigorously shaking the test tube, the syringe is again connected with the long tube for the purpose of bringing into suspension all particles adherent in the long tube. This is done by moving the piston back and forth a short distance. Finally, a portion of the water is allowed to remain in the syringe so that a drop may be transferred to the counting chamber.

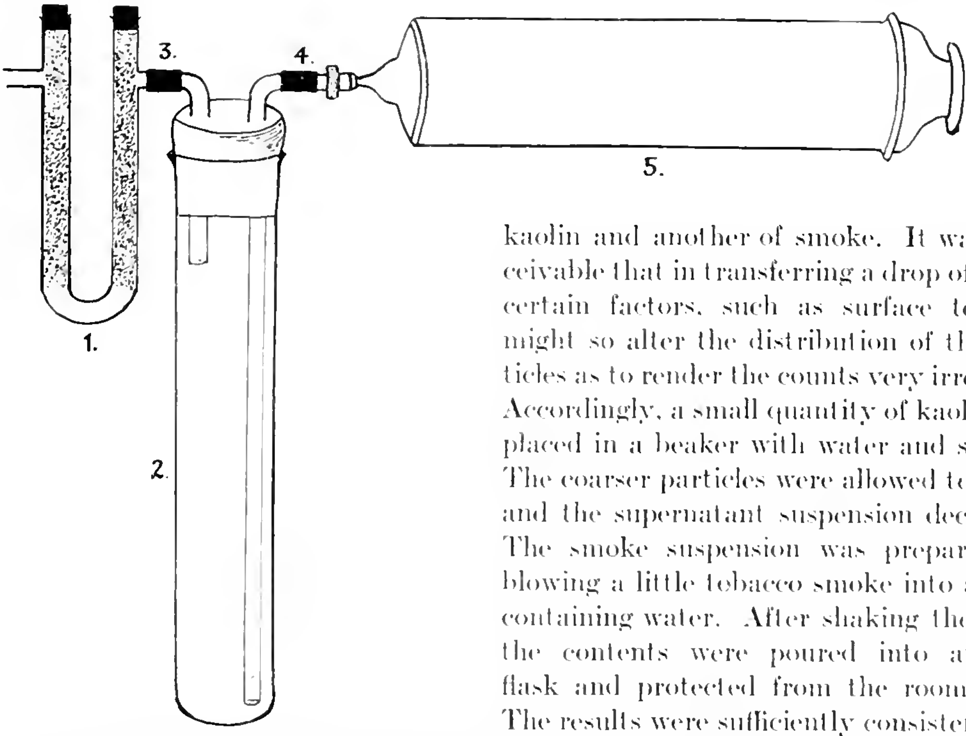


Fig. 2. — 1. Filter containing cotton-wool. 2. Test tube provided with glass stopper perforated by two glass tubes. 3 and 4. Pure gum connecting pieces. 5. Luer syringe.

## Results

Before proceeding with the actual determination of particles present in air, it appeared desirable to test the consistency of the method with a prepared suspension of kaolin and another of smoke. It was conceivable that in transferring a drop of water certain factors, such as surface tension, might so alter the distribution of the particles as to render the counts very irregular. Accordingly, a small quantity of kaolin was placed in a beaker with water and stirred. The coarser particles were allowed to settle and the supernatant suspension decanted. The smoke suspension was prepared by blowing a little tobacco smoke into a flask containing water. After shaking the flask, the contents were poured into another flask and protected from the room dust. The results were sufficiently consistent and clearly indicated that no factors operate to introduce serious irregularity in this part of the procedure.

Counts made with distilled water alone — not prepared with unusual care — showed an average number of particles per square millimeter of $12 \pm 2$. This figure is used as a correction in calculating the number of particles per unit volume of air. The distilled water is not entirely responsible for this count; some particles unavoidably remain on the ruled surface during the cleaning process.

The results of the determinations of the dust content of outdoor air and laboratory air appear in Table 1. The outdoor samples were obtained in a street comparatively free of traffic; those of indoor air were taken in one of the rooms of the laboratory

TABLE 1.—DUST PARTICLES IN THE AIR

| Date | Source of Sample | Number of Sample | Size of Sample (c.c.) | Time | Count per Sq. Mm. | | Difference | Average Count per Sq. Mm. | Particles per c.c. of Air |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1st Field | 2d Field | | | |
| October 30...... | outdoors | 1 | 103 | 10:30 | 34 | 28 | 6 | 31 | 36,800 |
| | | 2 | 202 | 11:10 | 40 | 50 | 10 | 45 | 32,600 |
| November 1...... | " | 1 | 202 | 1:30 | 31 | 29 | 2 | 30 | 17,800 |
| | | 2 | 306 | 2:05 | 38 | 50 | 12 | 44 | 20,900 |
| | | 3 | 405 | 3:50 | 53 | 60 | 7 | 57 | 22,200 |
| November 3...... | " | 1 | 205 | 9:45 | 55 | 54 | 1 | 55 | 41,900 |
| | | 2 | 207 | 11:00 | 52 | 51 | 1 | 52 | 38,600 |
| November 4...... | " | 1 | 102 | 10:30 | 33 | 38 | 5 | 36 | 47,000 |
| | | 2 | 202 | 11:40 | 59 | 53 | 6 | 56 | 43,500 |
| | | 3 | 205 | 4:40 | 50 | 53 | 3 | 52 | 39,000 |
| November 5...... | " | 1 | 205 | 1:42 | 43 | 53 | 10 | 48 | 35,000 |
| | | 2 | 302 | 2:50 | 58 | 56 | 2 | 57 | 29,500 |
| November 8...... | " | 1 | 306 | 10:30 | 64 | 68 | 4 | 66 | 35,200 |
| | | 2 | 203 | 11:50 | 43 | 44 | 1 | 44 | 31,500 |
| | | 3 | 101 | 1:25 | 27 | 30 | 3 | 29 | 33,600 |
| | | 4 | 205 | 2:40 | 39 | 51 | 12 | 45 | 32,100 |
| | | 5 | 100 | 3:50 | 31 | 31 | 0 | 31 | 38,000 |
| | | 6 | 102 | 4:30 | 25 | 32 | 7 | 29 | 33,300 |
| January 5...... | " | 1 | 102 | 9:35 | 47 | 63 | 19 | 57 | 88,200 |
| | | 2 | 202 | 9:42 | 92 | 103 | 11 | 98 | 85,100 |
| | | 3 | 207 | 9:47 | 96 | 101 | 5 | 98 | 82,600 |
| October 28...... | laboratory | 1 | 105 | 10:45 | 41 | 39 | 2 | 40 | 53,300 |
| | | 2 | 102 | 11:30 | 38 | 35 | 3 | 37 | 49,000 |
| | | 3 | 102 | 1:00 | 34 | 36 | 2 | 35 | 45,000 |
| November 9...... | " | 1 | 204 | 10:30 | 67 | 70 | 3 | 69 | 55,800 |
| | | 2 | 202 | 11:09 | 73 | 67 | 6 | 70 | 57,400 |
| | | 3 | 202 | 1:15 | 68 | 62 | 6 | 65 | 52,400 |
| | | 4 | 202 | 2:20 | 60 | 60 | 0 | 60 | 47,500 |
| | | 5 | 204 | 3:00 | 71 | 53 | 18 | 62 | 50,000 |
| | | 6 | 202 | 3:50 | 64 | 65 | 1 | 65 | 52,400 |
| November 10...... | " | 1 | 205 | 10:05 | 53 | 43 | 10 | 48 | 35,100 |
| | | 2 | 206 | 1:00 | 56 | 52 | 4 | 54 | 40,700 |
| December 28...... | " | 1 | 206 | 1:00 | 62 | 70 | 8 | 66 | 52,400 |
| | | 2 | 206 | 2:20 | 61 | 51 | 10 | 56 | 42,700 |
| | | 3 | 205 | 3:35 | 67 | 54 | 13 | 61 | 47,800 |
| December 31...... | " | 1 | 102 | 10:45 | 37 | 49 | 12 | 43 | 60,700 |
| | | 2 | 102 | 11:15 | 45 | 31 | 14 | 38 | 50,900 |
| January 4...... | closed cabinet | 1 | 102 | 1:10 | 31 | 34 | 3 | 33 | 41,100 |
| | | 2 | 101 | 2:05 | 33 | 35 | 2 | 34 | 43,500 |

in which there was generally but one occupant. If the dust content of the air were absolutely constant, our method would not permit us to expect a better agreement than the figures in the table actually show. With one or two exceptions, the average deviation of the number of dust particles per cubic centimeter of air is not more than $\pm 4,000$ for 100 c.c. samples, nor more than $\pm 2,000$ for 200 c. c. samples. The derivation of these figures will readily be understood upon recalling that the average count for distilled water is $12 \pm 2$. Owing to the small number of samples in most of the series, there is no significance in the fact that in one or two instances the above limits are slightly exceeded.

The results in the table, therefore, mean

that the amount of dust present in the air on any single day was, in general, practically constant under the conditions that prevailed when the samples were taken. When one bears in mind the errors incident to enumeration and the possibility of certain influences disturbing the dust content of the air, the agreement is remarkable. There is a variation from day to day and the figures for indoor air are on the whole higher than those for outdoor air, although they are not strictly comparable, having been obtained on different days. On the morning of January 5, the atmosphere was unusually smoky and the counts are correspondingly high. The samples of air from a closed cabinet free from disturbing influences are practically identical in their dust content.

## Discussion

Before the method was actually tested, it seemed doubtful whether one could hope for consistent results, partly because of the possibility of the inclusion of particles between the barrel and piston of the syringe and partly because of the exposure of the piston to the dust particles of the air. But experience showed that it makes no difference whether samples of 100, 200, or 300 c. c. are taken; in other words, whether the piston is withdrawn once, twice, or three times. These factors, then, if they operate, do not endanger the usefulness of the method. In the modified form of the method any error from this source would disappear.

One minute's shaking is sufficient to bring the particles into aqueous suspension. A more prolonged shaking does not increase the count. This is exactly what one would anticipate from the work of Katz, Longfellow, and Fieldner (3) who find that Palmer's apparatus in which the air is in contact with the water for a very brief interval retains 13 per cent. of smoke.

The same objection applies to this method as applies to all methods in which water is used as a medium. Water-soluble particles will not be included in the count. In many cases, however, particles lost in solution may be determined by chemical methods. Bill (5) points out that the particulate matter in the Palmer suspensions shows a tendency to form small masses or clumps. The minute particles in my own suspensions have not shown any agglomeration. Counts made of suspensions that were allowed to stand for nearly two hours were practically as high as those made in the beginning.

In routine work, such as the examination of air in factories, where several samples taken at short intervals are desired, the contents of the syringe may be emptied into small 25 c.c. Erlenmeyer flasks and covered with rubber membrane secured by an elastic band. In the modified form of the method, a series of test tubes each provided with a glass stopper perforated by two glass tubes (Figure 2) may be employed.

## Conclusion

1. A method has been presented in the foregoing pages, based on the enumeration, by oblique illumination, of minute particles in a sample of air brought into aqueous suspension by shaking the sample with water.

2. Success in the use of the method demands strict attention to cleanliness.

3. The method requires but a very small sample of air and yields consistent results.

4. The method ought to be especially suitable for the determination of smoke particles and should also prove useful in determining the efficiency of air-filtering devices in ventilation systems.

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# ANILINE POISONING IN THE RUBBER INDUSTRY*

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ANILINE ($C_6H_5NH_2$), a primary amide of benzol, is a colorless, volatile oil which, when exposed to air and light, is very unstable, and rapidly changes in color to dark brown and even to black, leaving a residue. It can be produced in several ways but the most common commercial method is by the action of hydrochloric acid and iron filings on pure nitrobenzol ($C_6H_5NO_2$). It is used principally in the manufacture of aniline dyes, photographic materials, rubber compounds, and shoe polishes.

The aniline of commerce is contaminated by very small to large amounts of nitrobenzol, dimethylaniline, and its nitroso bodies, all of which have a predilection for action on the blood and nervous system, similar to all homologous derivatives of benzol. Von Jaksch (1) claims that, as far as records show, pure aniline does not produce poisoning, but that it is the mixture of amidobenzene, meta-toluidine, para-toluidine and ortho-toluidine and xylidine which is poisonous. It is the experience of Dr. Alice Hamilton (2), however, that "chemically pure aniline produces all the symptoms and blood changes characteristic of industrial anilism." The experiments of K. B. Lehmann show that pure aniline is very toxic in even smaller quantities than carbon disulphide, toxic symptoms following the inhalation of 0.1 to 0.25 gm. of aniline, while it takes from 1 to 1.1 gm. of carbon disulphide to produce symptoms of poisoning.

## Methods of Absorption

The poison may enter the body through the skin, the respiratory tract, the alimentary tract, and through a combination of these three ways. Aniline oil is readily absorbed by the skin, and in a very short time produces marked symptoms. One case is recorded in which death resulted from poisoning due to absorption through the skin of the feet from a pair of shoes which had been colored with aniline dye and had been put on before the dye was dry. A large proportion of the cases which I have seen have developed their symptoms from skin absorption.

Respiratory absorption is also very common. Individuals working in aniline or any of its derivatives in rooms where the ventilation is poor and the aniline bodies are subject to heat develop typical aniline symptoms after varying periods of time, depending on the concentration of the gaseous substance. Absorption through the alimentary system is the smallest factor in producing symptoms of aniline poisoning and one which can be controlled largely by education and instruction concerning the necessity for cleanliness during eating and drinking. The most serious results and the most acute symptoms are produced by a combination of all three methods of absorption.

## Clinical Picture

*Symptoms.*—The characteristic symptoms of aniline poisoning in the order of their appearance as observed in many cases are: slight insomnia or drowsy feeling; neurovascular symptoms, such as flushed face, weariness and mental uncertainty in extreme cases, and sometimes an irritable disposition; headache, dizziness and nausea; beginning cyanosis, chilliness and a sensation of cold; pulse, rapid and weak, gradually becoming slower with de-

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creased blood pressure; loss of appetite, indigestion; irregular respiration; dryness and choking sensation in the throat, burning and stinging sensation of the eyelids; joint pains, muscle pains; spots before the eyes; hematuria in rare cases; painful urination in extreme cases, and hyperacidity; constipation or diarrhea; skin eruptions, macular in rare cases; difficulty in talking, accompanied by loss of memory; very deep cyanosis followed by unconsciousness; and in rare cases, hemoptysis. Each patient does not, of course, present all symptoms, but he may have had them at some time. The marked pallor of the skin, cyanosis of the lips, and a history of work in aniline, together with a characteristic odor of aniline which is usually present, should remove any doubt about the diagnosis.

There is a class of men who work in aniline who seem to acquire a tolerance for the substance, in that they remain cyanotic for years without the development of any apparent, serious symptoms. Through a change of work, however, such mild symptoms as do appear clear up, the blood and urine return to normal, and we diagnose the cases as chronic. These patients have some blood changes, of course, yet they feel no ill effects except for a slight tired feeling at the end of a day's work. The body attempts to maintain an equilibrium between intake and output of aniline, but there is a surplus amount which is absorbed and which causes blood changes that are responsible for the marked cyanotic condition.

*Laboratory Findings.*—The blood changes consist principally in the formation of methemoglobin and a coincident decrease in hemoglobin, with resulting deficient oxygen supply to the tissues. There is also a decrease in the number of red blood cells, with anisocytosis and poikilocytosis, and in very acute cases there may be a slight leukocytosis and basophilic degeneration of the red cells. After the removal of the patient from contact with aniline or its derivatives, the leukocyte count returns to normal and in some cases even a slight leukopenia is found. There frequently occurs a diminution of polymorphonuclears with a corresponding increase in small lymphocytes, and a slight eosinophilia.

In very severe cases of poisoning, some embryonic forms of red cells appear, the hemoglobin (Sahli's method) is decreased, and there is considerable formation of blood dust. Tallqvist's scale cannot be used with any success, for as soon as the methemoglobin is exposed, the color is changed. In the advanced cases, the coagulability and the viscosity of the blood are diminished.

After examining over 100 urines from cases ranging from those with marked beginning symptoms to those with persistent symptoms, I am of the opinion that no definite rule for urinary findings can be formulated, except that in the most severe cases, if large quantities of urine are tested, there can be found traces of hematin, presumably due to blood cell destruction. The following is a summary of the urinary findings from the cases which I have examined: specific gravity, 1.005 to 1.030; reaction, usually acid, a large amount of uric acid being present; albumin, negative, except in cases where extreme anemia had resulted; sugar, negative; aniline or aniline radicals, negative; phenol, negative; acetone, negative; diacetic acid, negative, except in severe cases. Nearly all cases showed traces of hematin when twenty-four-hour specimens were evaporated.

Microscopic examination generally revealed large quantities of uric acid crystals, urates, and oxalates. One case showed marked kidney involvement. It could not, however, be proved that this was caused by aniline, as this man's condition before he went to work in aniline was not known. In one case the urine was cloudy and, on mi-

croscopical examination, no formed elements were found, but large quantities of fat globules were present. In another case, diacetic acid was found, but no trace of sugar; while in still another, there was present diacetic acid with a slight trace of sugar. Two cases showed bladder involvement which improved under change of work and treatment.

*Complications.* — In severe cases especially, there may appear certain complications such as secondary anemia, which it is difficult to clear up; an irritative cystitis; and inhibition of the red-cell forming organs — a condition which gradually returns to normal when the patient is removed from contact with aniline. In alcoholics a predisposition to glomerular nephritis is often noted.

Several cases of gastric involvement, especially gastric ulcers, have been reported by German authors, but I have never seen a case of gastric ulcer develop, in which aniline was the cause. I know of one instance in which a worker with gastric ulcer claimed that it was due to aniline, but investigation proved that he had been exposed to very little aniline and only for a period of a few minutes. Sometimes eczematous skin rashes appear, particularly on the covered parts, the scrotum, the arm pits, and inguinal regions, and occasionally we see a pustular eruption resembling a furunculosis. Examination of the pus from one of these furuncles shows staphylococci and streptococci.

## Prevention

The most important factors in the prevention of aniline poisoning are: (*a*) education and instruction of employees working in aniline; (*b*) proper ventilation (forced); (*c*) handling of aniline compounds in closed receptacles; (*d*) restricted length of time for working in the fumes of aniline; (*e*) better personal hygiene; (*f*) an immediate bath if aniline or any of its derivatives are spilled on the clothing or the skin; (*g*) protection of the hands by rubber gloves, and of the feet by wooden shoes, rubber boots, or rubber-soled shoes in production plants where the floors are wet with aniline.

Some employers furnish milk for their employees to drink, but I see no advantage in this; in fact, rather the opposite, for milk is constipating and thus blocks one of the channels of excretion. One large manufacturing company gives its aniline workers a teaspoonful of vinegar (acetic acid) before they go to work, with the idea of producing soluble aniline compounds which may be excreted by the kidneys. Personally, I have obtained very good results from the use of lemonade containing Epsom salts. It furnishes the average worker with enough citric acid and salts in a day to increase catharsis and diuresis. The following is the formula which I have used:

| | |
|---|---|
| Oranges | ½ to 1 dozen |
| Lemons | 2 to 2½ dozen |
| Water | 8 gallons |
| Saturated solution Epsom salts | 16 ounces |

Sugar to taste.
Serve cold.

It is advisable that all persons working in aniline should be examined at frequent intervals and a record of the examination made. The form illustrated in Figure 1 has been found to be very convenient for this purpose. The foreman who has charge of aniline workers should be instructed concerning the hazards of the work and should report any men who show symptoms of poisoning. All aniline workers should have short periods to work and longer ones to spend in the open air. They should abstain from alcohol as it seems to predispose to aniline absorption, particularly in young men.

## Treatment

Preventive treatment is, of course, the best to pursue. When poisoning has al-

Figure I

## SPECIAL EXAMINATION FOR ANILINE WORKERS

Age  Nationality  M.S.W.  Date

How long have you worked here?  How long in the department?

Have you felt perfectly well during the past year?  Past six months?

Have you ever had, or have you now any of the following:

Muscle weakness, twitching of muscles, or muscle pains
Large amounts of saliva
Exhausted or "tired out" feeling
Fast or slow breathing
Drowsy or sleepy feeling
Rapid heart
Chilliness or cold feeling
Nasal trouble, catarrh, discharge into back of throat from nose
Indigestion  Constipation  Diarrhea  Vomiting  Nausea
Nervousness  Irritability  Headache
Joint pains
Unconsciousness  Dizziness  Loss of memory
Difficulty in talking
Spots before eyes
Spitting of blood
Cold hands or feet
Dryness or choking sensation in throat
Burning or stinging sensation of eyelids
Painful urination
Skin eruption  Duration
Loss in weight in the last six months

### *Physical Examination*

| | | | | |
|---|---|---|---|---|
| General appearance | | | | |
| Face and head | | Eye reflexes | | |
| Thorax | Lungs | Heart | Pulse | Blood pressure |
| Abdomen | Liver | Spleen | Stomach | |
| Genitalia | | | | |
| Reflexes | Knee jerk | Babinski | Romberg | |
| Extremities | | | | |
| Skin | Areas of anesthesia or hyperesthesia | | | |
| Blood: Hemoglobin | White cells | Red cells | Pathological cells | |
| Urine: Specific gravity | Albumin | Sugar | Reaction | |

Remarks:

*Examining Physician*

ready occurred, however, the patient must be treated for oxygen lack and acidosis. Very mild cases need free elimination and open air, while the more severe ones require artificial respiration, injections of heart stimulants, and blood transfusion.

In acute cases the first step is to remove the patient to the open air, loosen his clothing and examine it as a possible source of absorption. If it is found to be saturated with aniline fumes, it should be taken off at once. Give oxygen inhalation, if necessary, remove the excess of aniline from the surface of the skin with soap and water, and with a vinegar bath dissolve the aniline from the pores of the skin. Use heart stimulants, such as caffein, camphorated oil, or ether, but no tinctures because of the alcohol which they contain and which should be abstained from. An enema of soap suds and glucose (2 to 3 ounces) may be given. If the patient is conscious, give him 1 ounce of glucose in water, alkalinized with sodium bicarbonate. Blood letting, transfusion, or possibly infusion of normal saline may be necessary. Lavage of the stomach has been resorted to, but seems to be more hazardous than beneficial. It is important to promote the excretion of the poison by free diuresis, catharsis and sweating. The various symptoms should be treated as they appear.

## Summary

Aniline and its immediate homologues are blood and nervous system poisons which produce their effects by internal suffocation. They cause destruction and hemolysis of the red blood cells and marked production of methemoglobin, and, in severe cases, acidosis. In acute cases, a slight basophilic degeneration of the red cells also takes place. Very little effect is produced on the white blood cells, the only change being a transitory leukocytosis in the beginning of acute cases.

There are very few complications except in severe cases.

Alcohol seems to be a predisposing factor for early symptoms.

Preventive measures should be instituted in preference to after-treatment.

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# OIL FOLLICULITIS *

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THE marked increase in our industrial population makes a study of the occupational affections of the skin of special importance. These affections will tend to increase as greater numbers of persons are drawn into the industries, as new industries are developed, and as new products are introduced. This paper is concerned with skin affections due to oils, and particularly with those due to the use of machine oils, an investigation of which was undertaken to determine the cause of an outbreak of furunculosis among the employees of a machine shop.

Affections of the skin due to petroleum and its products have long been recognized, various terms being used to designate them. By some authors they are considered as belonging to the eczemas, and by others as dermatites or dermatoses. There is, indeed, a considerable amount of confusion as to the correct terms to be used for all the various skin diseases, and those due to occupations are not exceptions. R. P. White (1), in discussing the question of terminology, says "It would seem that, as a term intended to express a whole group of these disorders, the word 'eczema' is both incorrect and inadequate. It would, therefore, seem more convenient and logical to use the non-committal term 'dermatitis.' This will embrace all so-called trade eczemas, as well as other forms of skin disease caused by employment, and where possible the name of the offending agent should be prefixed to it." Following White's suggestion, we might designate skin affections due to oils as *oil dermatites.* This does not, however, clarify the matter to any extent, since the different oils produce different affections. In the case of machine oil, the trouble seems to be largely a mechanical plugging, followed by inflammation and infection of the follicles. For this reason we suggest the name *oil folliculitis.*

## Historical Review

An exhaustive study of skin affections due to occupations has been made by Knowles (2). In the course of his discussion, this author says "fully one-quarter of all cases of eczema are of definite external origin. Almost one-sixth of all cases of this affection is caused by the occupation of the individual. . . . The largest number of cases of the so-called occupation eczemas are seen in the workers in the household and next most frequently in laborers. Practically every occupation and every irritant may produce an eczema." Knowles' paper reports forty-five cases of eczema in individuals who handled oils, greases, carbon, graphite, etc. Oppenheim (3) in Germany examined 1,800 operatives who presented themselves in his practice, and found that 400 of the cases, or 22.2 per cent., were due to the employment of the patients.

The earlier works upon the harmful effects of petroleum and its products upon the body were confined largely to the poisonous or intoxicating action when these substances were taken internally. Lewin (4) in an article written in 1888 gives an ex-

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tensive bibliography of the earlier literature on this subject, and also reports results obtained by feeding oils to animals. He refers to two early descriptions of skin affections due to petroleum, the first (5), designated as "eczematous," the second (6), described as consisting of small ulcers with erysipelatous red bases, or as consisting of blisters with red but not indurated bases. After the latter type of ulcer had once been healed, it did not develop again, even though the patient continued in contact with the product.

J. C. White (7), on the other hand, states that he has recommended petroleum for many years for the destruction of scalp and pubic lice, and has never seen the slightest indication of irritation from its use. He also states that he has seen teamsters wash their faces and hands in the oil without ill effects. In conference with the superintendent of a large refinery, Dr. White found that there was very little skin trouble among the workmen and that whatever irritation there was appeared mostly in hot weather, and only among a few of the workmen handling paraffin products. The lesion in these cases consisted of a mild degree of eczematous inflammation on the backs of the hands and forearms, which disappeared rapidly after the occupation was given up.

Lewin (4) discusses at some length an outbreak of pimples, boils, acne, and black comedones on the hands, arms, and other parts of the body in a group of workmen in the petroleum industry. This affection continued for different lengths of time and with varying severity in different individuals, in some instances continuing as long as the men were employed in the work. It appeared to Lewin that the inflammation went hand in hand with the stopping of the hair follicles and sebaceous glands. After these were closed, there was a continuation of glandular secretion, but excretion being inhibited, the condition was gradually exaggerated and soon involved all layers of the skin. The longer the process continued, the more intense the inflammation became, finally spreading to neighboring glands and hair follicles, or to the subcutaneous tissue. In the course of his study, Lewin found that the heavier petroleum products, particularly those which distill at 250°–360° C., possessed the most marked property of causing inflammation. He tested the action of these products by feeding them to animals, and considered that the action upon the stomach wall was similar to that on the skin. He also noted that the individuals of most cleanly personal habits suffered least from this trouble. Similar skin affections have also been described by Ogston (8) as due to the paraffin products from cannel coal and various other raw petroleum products.

A folliculitis and perifolliculitis of spinners called *bouton d'huile* was first described by Purdon in Belfast in 1867, and by Leloir (9) in Belgium in 1889. This affection was due to the irritating action of the oil used on the machines. In England sperm oil was the most common lubricating agent; in Belgium, on the contrary, mineral oil was largely used. The oils from Russia were usually unmixed, as were those from America, while the shale oil from Scotland was usually mixed with olive or colza oil in the proportion of ten to fifty parts per hundred. Purdon (10) in his article discusses an acneform eruption of "doffers" (usually young girls who remove the bobbins and clean and oil them) in flax spinning mills. The affection is evidently a folliculitis due to the sluggish action of the sebaceous glands, the orifices of which are choked by the oil and irritated by the flax water that comes off the bobbins. The eruption, which occurs usually in persons under 20 years of age, of either sex, but chiefly in girls who expose their arms by wearing short sleeves, may be described as follows: The acne eruption commences with a small, dull red papule, shotty to the touch, occurring on the forearms and

wrists, and when a little matured has a small black speck in the center of the papule, like a comedo, showing the plugged sebaceous follicle. Next, the papule increases in size, finally suppuration occurs, and the papule disappears.

In Belfast, Purdon did not find eczematous conditions of the hands such as those described by Leloir in Belgium. In describing the trouble, Leloir says that it is seated in the hair follicles; these become dilated and filled with broken hairs and horny cells mixed with dirt and oil, thus setting up a perifolliculitis. The corium around the follicle becomes infiltrated with round cells, the vessels dilate, and some of the tissues necrose. Eventually the whole follicle may be discharged.

Lefebvre (11), writing in 1888, states that skin lesions of the nature described above are of fairly common occurrence, and are liable to arise wherever dirty oil from the joints and gearing of the machinery constantly comes in contact with the skin. In spinning mills this may be effected directly by the fine spraying of the oils from the spinners revolving in the oil cups, or indirectly from saturated clothing or cleaning rags. The condition is easily recognized by the stippled ground of minute, black, dilated follicles, upon which the typical rounded, well-raised, hard papules of a dusky red color are irregularly dotted. These papules vary in size from that of a hemp seed to that of a split pea, and are centered by a hair. They may become surrounded by a zone of erythema, or may develop into an acute boil. Usually, however, they are indolent lesions which form slowly, take many weeks to recede, and leave a pitted scar.

Collis (12), in England, reported fourteen cases of dermatitis in engineering shops among workers whose skin had been much irritated by cooling and lubricating mixtures consisting of turpentine and alkaline emulsions of mineral oil. This disease failed to appear when neither turpentine nor mineral oil was used.

R. P. White (1), discussing the effect of petroleum, says that in all instances in which raw petroleum is handled, the workers suffer, whether it be at the mines, refineries, pumps, or in the manipulation of the raw petroleum itself. He states that from 1890 to 1893 eighteen cases of petroleum acne were reported in French refineries, and in the official statistics, which included 1,380 petroleum workers in Russia, nine were reported to be suffering from general symptoms, and forty-three from petroleum acne. Rambousek (13) makes the statement that opinion is unanimous as to the injurious action of mineral oil on the skin, and particularly that the graver consequences are produced by the petroleum residues. The products of the distillation of petroleum and coal appear to have the same effect.

Oppenheim (3) has noted diseases of the sweat and sebaceous glands in paraffin and petroleum workers, who develop an "acne petrolei" most marked where the clothing is saturated with the heavy oils, especially on the "streckseite" of the arms and thighs. The heavy petroleum products are considered by him to be the most common cause of this trouble. He quotes Milliard as stating that half the men employed in the petroleum refineries in Rouen suffered from acne, most of them coming in contact with the heavy oils. He maintains that "Batschöl" and "Juteöl" produce the so-called "Weberakne," and that machine workers may suffer from "Schmierölakne."

Weichardt and Apitzsch (14) studied the cause of an outbreak, among the workers in the metal industry, of a skin disease consisting of small comedones and pustules which developed first on the hands and forearms, and later on other parts of the body. This disease became very serious among the machine workers, usually developing within approximately two weeks

after employment. The authors consider that the characteristic clinical picture may be ascribed to different causes and that in the beginning the local trouble may perhaps be due to an effect of the mineral oil which reduces the resistance of the skin and allows the entrance of secondary septic micro-organisms or their by-products. In studying their problem experimentally, Weichardt and Apitzsch found that machine oils applied to the ear of an albino rabbit caused severe inflammation. Olive oil rubbed on in the same manner had no such influence. Pure liquid paraffin was without effect, although the repeated application of pure mineral oil caused some irritation. On examination the machine oil was found to contain no free acids and alkalies. Although it contained 8 per cent. of resin, the oil still retained its irritating properties after the removal of this substance; it also contained a considerable amount of easily oxidizable substances and unsaturated compounds. The authors used several methods of saturating the oil by use of halogens but were not able to eliminate its irritating action upon the skin of rabbits.

C. J. White (15) states that "machinists of all sorts have a common enemy in dirty oil, which is rubbed into and absorbed by the follicles of the skin, and if boils don't follow, eczema may. The necessary cleaning at the end of the day's work adds its quota to the harm to which these men's skins are subjected. . . . Paraffin workers seem to be particularly prone to skin diseases. The substance harbors . . . many provoking ingredients, mostly mineral oils, and constant contact with this medium, with the consequent impregnation of the clothes, may produce eczema, pustules, and in the end cutaneous cancer."

Allworthy (16) mentions an aceneform eruption of "doffers" in the flax spinning mills of Belfast. He states that the eruption is probably produced by dirt, sweat, and the sperm oil which is used on the machinery. In discussing this statement, MacLeod affirms that the aceneform eruption is an example of oil acne, or *bouton d'huile.* "In it the follicles become plugged with a mixture of dirt and oil which causes inflammatory changes and produces the acneiform lesions. This condition is met with, not only in flax spinners but in any form of work in which the skin is liable to be bespattered with oil, such as in stokers, engineers, mill-hands, etc. It is a milder form of the dermatitis from petroleum, shale oil, etc., which tends to go on to warty growths and cancer. It occurs on the arms from the drops of oil and on the legs from contact with clothes saturated with oil."

Oppenheim (17) mentions serious irritations of the skin of the face from the use of impure vaseline salves which he employed in the treatment of lupus vulgaris. The skin became rough, harsh, uneven, warty, whitish and hard. Some of the softer nodules had a yellowish central point. This statement was discussed by Sachs (18), who affirmed that an acne-like eruption may develop alone or associated with eczema upon persons in contact with petroleum, tar, asphalt or pitch, and that Wacker and Schmincke in the Borst Institute had found forty-nine different substances (fats, oils, paraffin), which by experimental test gave rise to épithelial proliferation.

Deeds (19) investigated an outbreak of furunculosis among employees of a steel plant and found that "the epidemic apparently had its beginning in the case of the engineer at the plant, who was wont to clean his hands daily in the barrel of paraffin oil. Thereafter the cases appeared until each of the fifteen workmen had been so infected." The work done by these men was the handling of steel bars, which were coated with a mixture of paraffin oil and petrolatum to prevent rusting, and the hands of the men were constantly covered with this grease. Deeds considered that the

pyogenic organisms were carried from one man to another by the grease. *Staphylococcus pyogenes aureus* was isolated from the hands of the men but not from any of the grease used.

Thibierge (20) states that the *bouton d'huile* became so serious among the "tourneurs d'obus" that it made an actual difference in the functioning of the war factories. The lesions occurred in both men and women, most commonly on the hands and forearms, or on the face, if directly exposed to the lubricant, and on parts of the body exposed to oil-saturated clothing, especially the anterior aspect of the thighs. This trouble was generally most pronounced and extensive in individuals who had been employed for some time, and in the case of the "tourneurs d'obus" it became a veritable professional stigma. Necessity required the use of products of inferior quality and irritating nature (oil of petrol, etc.), and because of their scarcity it was impossible to purify them. They became charged with dirt and debris, which were deposited upon the skin and which clogged the mouths of the glands. The metallic particles were retained by the lubricating bodies, which in themselves were more or less irritating, and a special form of acne resulted. At this phase histological examination showed nothing of the follicular reaction. Finally the products of glandular secretion accumulated and became infected by pyogenic bacteria, and folliculitis and perifolliculitis developed.

Albaugh (21) states that furunculosis and wound infection "are unusually common in operators of lathes and cutting and milling machines, who come in contact with cutting compounds and cutting oils, where these lubricants are caused, by gravity or force, to flow in a steady stream on a job at the point of application of the tool. It has been observed, also, that these infections are more prevalent during the summer months, the exact reasons being unknown." Albaugh is not inclined to accept the idea that these affections are caused solely by the bacteria which are present on and in the skin, and which are allowed to set up an infection following injury by the oil; he believes rather that the oil itself may serve as a vehicle of the infectious material — a surmise which is further supported when the different types of skin affections are scrutinized as to their relation with the different substances.

Records of a three months' period showed forty-one cases of furunculosis and twenty-six cases of wound infection occurring in twenty-six departments of a factory employing 1,365 men, and probably many more cases were treated outside the plant. Few of these men had been troubled before coming in contact with cutting compounds or cutting oils. The men denied spitting into the reservoirs, although several of them were observed to do so in spite of instructions to the contrary. As the oils were collected from the machines and used again, this was an extremely dangerous practice. Albaugh goes on to say that "due to these exposures, pollution is almost certain to follow, especially in those cases where employees have acne or where they have pus infections of the skin, or mouth, or respiratory tract. This is most serious where machines are equipped with individual oiling systems, and where cuttings and shavings are collected from the different machines and the oil drained off and filtered.... This is also true of machined parts which are covered with oil and subsequently handled by men in other departments."

In his investigation among lathe workers of infections which appeared to be true pus infections, Shie (22) states that "a pin-prick, if left unattended, developed into a severe lymphangitis; a slight scratch in twelve hours into a linear mass of pus; a slight abrasion into a suppurating ulcer; and a laceration into a mass of necrotic tissue and pus."

Blum (23) has recently submitted an article on the skin affections due to oil which he has called *élaiokoniose folliculaire (bouton d'huile)*. He states that it is not the oil which plays the most important rôle, but in reality the foreign bodies carried by the oil, metallic particles and dust, which contribute to the obliteration of the follicular orifices. The oil is thus the vehicle and not the pathogenic agent. It is to the dermatitis of this type that the author attributes the name *élaiokoniose folliculaire* (ἔλαιον, huile and κόνιος, poussière) — "a general name used to designate the special affection of the pilosebaceous follicules observed in laborers whose skins are greased by lubricating or other oils, or whose pores are impregnated and fouled by dust in suspension." The trouble appears gradually, first generally on the hands and postero-internal face of the forearms and on the backs of the fingers. It appears occasionally on the thighs and abdomen as a result of wearing clothes saturated with the oil, and sometimes on the face and neck of attendants on machines which throw the oil to some distance. More often the lesions on the face and neck are due to scratching or to the worker's passing his hands and forearms over his face to remove the sweat.

## Type of Lesion Due to Oils

R. P. White (1) attempts to classify the effects upon the skin of petroleum and its distillates which, generally speaking, cause varying grades of dermatitis, roughly corresponding to the temperatures at which they are given off: (*a*) Benzine, or petrol naphtha (boiling point 150° C. and under), causes superficial inflammation of the skin, with dry, scaly conditions, or eczematous lesions showing fine vesicles, pimples or pustules. (*b*) Lighting oil (boiling point 150° to 300° C.) causes papular and pustular eczema, miliary folliculitis, with or without perifolliculitis (acne), and abscesses. (*c*) Residuum (boiling point above 300° C.) causes erythema, keratosis senilis — punctiform folliculitis, warts, ulcers, and carcinomata. "These appearances are not necessarily sequential the one upon the other, and mixed lesions prevail amongst the workers, especially in the distillates coming off at the higher temperatures."

Dr. White also states that the existence and intensity of a trade dermatitis depends upon three factors. In order of importance they are: (1) the potency of the irritant; (2) the resisting quality; and (3) the reactive capacity of the skin.

According to Besnier, Brocq and Jacquet (24), the acneform folliculitis, a pseudo-comedo, is uniquely an appendage of trades in which are handled tars, petrols and the residues of their distillation known as heavy oils. They state that the vesicular and pustular dermatites are very frequently the origin of lymphangitis and adenitis which may result in suppuration. These complications are rare in spontaneous eczema.

Pusey (25) states that in addition to the irritants that produce the usual inflammatory reactions, there are certain substances that produce lesions in the skin which are not of the ordinary inflammatory type. The substances which do this especially are tar, mineral oils and greases, and their derivatives, and, perhaps, true fats. The commonest lesions which these substances produce are boils and large crops of blackheads and pustules. Such eruptions are seen not infrequently in men habitually exposed to these substances in their occupations.

Bridge (26) divides oil injuries into two classes — the first, the injury due to the plugging of the small glands at the root of the hairs; and the second, the mechanical injury produced by metallic particles suspended in the cutting lubricant. The former is primarily mechanical; the mixture of dirt and oil blocks the opening of the glands and, while secretion continues,

excretion is prevented and an inflammation is caused (folliculitis). The glands may be invaded by bacteria and suppuration results in a boil. Mechanical injury due to particles of metal suspended in the oil usually occurs on the hands, where two surfaces are rubbed together, or on the arms, from wiping with a cloth or waste when the skin is coated with a film of oil in which metal particles are suspended. This injury allows the entrance of bacteria from which infection may result. Often the oils become infected and thus spread the condition among the workmen.

Hubbard (27) states that an improper practice, and one which frequently causes skin diseases in mechanics, is that of spitting into oil receptacles or trade materials, which subsequently have to be used or handled by workmen. Oil infected by spittle, especially when used in lathe work, quite often causes boils. Grinders frequently blame the ingredients of preparations used by them, when investigation has shown that their trouble was due to careless workers spitting into the material.

The *bouton d'huile* in its most advanced stages is characterized by Thibierge (20) as a round pustule 2 to 6 or 8 mm. in diameter, generally little raised, with resistant walls enclosing a thick pus. This pustule is habitually surrounded by a narrow inflammatory, red, slightly infiltrated zone, and has little tendency to open spontaneously. Once having been opened, however, the orifice remains so for one or two weeks and the slight inflammatory zone surrounding the pustule disappears slowly. Besides this type of pustule, there are other longer pustules without infiltration at the base, which develop more rapidly and produce large quantities of pus. These tend to multiply by auto-inoculation and present many of the characteristics of a streptococcic erythema. This latter affection is not considered the same as the *bouton d'huile.* In many individuals there develop large numbers of acne comedones usually centered by a hair.

The affections described chiefly by Albaugh were true furunculoses and wound infections, which are apparently much more severe than the oil acne, *bouton d'huile* or *élaiokoniose.*

In his description of the *bouton d' huile,* Blum (23) states that in the beginning there is a slight itching. Little by little there develop numbers of black points which cannot be removed by washing, many of them presenting projections more or less pronounced, at the center of which the hairs appear old or broken. This stage corresponds to the obstruction of the follicles by dust (konioses) mixed with oil and develops into a veritable acne comedo. Later infection sets in, generally around the follicle, causing a perifolliculitis which clinically has the appearance of a pustule. These pustular lesions are red, violet or brown, sometimes "jambonné"; they are generally flattened, more rarely conical, and represent variable dimensions, from the size of the head of a pin to that of a pea. Some of the pustular lesions have a raised center containing a drop of yellowish pus centered by a black point; the papule has become a papulo-pustule. In other cases, there are vesico-pustules having a vesiculiform aspect. At other points the infection is a true folliculitis and more deeply seated, and in some cases true furuncles develop. There are thus, according to Blum, four stages, all of which may appear in the same patient at the same time: (1) the stage of the black point; (2) the stage of acne comedo; (3) the pustular and papulo-pustular stage; and (4) the furuncle stage. It is evident, then, from the above references, that the action of oils will depend upon the type and grade of oil, the conditions under which it is employed, the length of time it has been used, the kind and amount of microbial contamination and the kind and amount of dirt, dust and metal in suspension.

### Influences Predisposing to Affection of the Skin

The structure of the skin renders it specially able to resist the action of agents likely to injur it and allow the invasion of micro-organisms. Its toughness and elasticity permit it to resist mechanical injury, while the chemical nature of its secretions prevents to a certain extent the action of chemical agents. In discussing this point, Jacquet and Jourdanet (28) make the statement "that one rarely finds traumatic eczema on the palms of the hands, where the sweat and grease are abundant and well mixed; that eczema is more common in winter [when the secretions are apt to be deficient]; and that an oily skin is less affected than a dry skin." This is not true in the case of affections due to oil, since they are more commonly reported in the summer than in the winter. This may be due to the fact that in the summer the follicles are more open and more easily clogged by the dirt carried by the oil, and that micro-organisms more easily penetrate into the follicles under these conditions.

There are certain factors which may predispose to infections of the skin, such as defective structure or function — congenital or acquired, permanent or temporary — or unusual environmental conditions. The age of the individual is also important. In the infant, ordinary soap may cause irritation, and in extreme age the skin is more easily injured and has less recuperative power than at earlier periods of life. Sachs (18) has shown, however, that the skin of old rabbits is much more resistant to the action of certain irritant aniline colors than the skin of young animals.

Abnormal activity of the sebaceous glands may predispose to injurious effects of certain substances such as oil, tar, and petroleum. Unnaturally profuse sweating is undesirable in certain industries, since there is increased tendency to retain the irritant on the skin and to increase its solubility.

R. P. White (1) states that an occupational disease once induced may predispose to recurrences of skin diseases not produced by the primary cause. Fordyce (29) maintains that in chronic skin diseases one of the most prominent features is the increased susceptibility which the skin either presents from the beginning, or which develops as the process advances. This may be referred to a state of anaphylaxis. Persons who show an increased susceptibility to irritants may, perhaps, be sensitized to the toxin of pyogenic organisms just as patients with tuberculosis may be sensitized to tuberculins. Such hypersensitive or abnormal skins are sensitive to small amounts of irritants not affecting normal skins and this condition may pave the way for the entrance of micro-organisms normally present on the skin or added by contact.

The French writers attach considerable importance to the influence of constitutional disarrangements in skin diseases. Thus, a skin poorly supplied with blood is more subject to the action of irritants and to invasion by bacteria. It is also well known that digestion and nervous disorders, alcoholism and diabetes mellitus affect the resistance of the skin to infection. In some clinical investigations in this connection, Jacquet and Jourdanet (28) found that the cure of certain gastric disorders was followed by great improvement in the severity of local traumatic skin troubles, and by the prevention of relapses. They claim that the careless bolting of food, especially if indigestible, can in itself exercise an injurious influence upon occupational eczema, proportionate to its severity. They also demonstrated that irritable conditions of the mucous membranes, and overdistension of the stomach are associated reflexly with pathological states of the skin.

Alderson (30), in discussing increased

vulnerability of the skin due to systemic conditions, states that "in considering the skin, we must not forget that it is an important organ intimately connected with and influenced by all the various bodily functions, among which the digestive system plays an extremely important part. Various disorders of the nervous system and internal gland system are often the cause of increased susceptibility of the skin to injury." In discussing increased vulnerability due to local conditions he declares that "a person whose skin is congenitally defective, particularly in the outer layers, is very much more liable to develop trade dermatoses than one with a normal epidermis. . . . A deficiency in secretion is liable to result in lowered tone and lowered resistance to chemical and mineral irritants as well as to atmospheric and thermal conditions. On the other hand, an excessive sebaceous secretion is prone to clog the follicles and the ducts resulting in increased irritation and vulnerability. Skin of this sort is usually favorable soil for bacterial growth. It is particularly sensitive to the deleterious effects of various oils, tars, paraffin, petroleum and allied substances."

Skin diseases in general, and those due to oils in particular, are considerably influenced by secondary invasion by micro-organisms, and according to Besnier, Brocq and Jacquet (24) it is correct to say that the secondary micro-organisms determine the character of the dermatosis.

Bender, Bockhart and Gerlach (31) and Bockhart (32) studied the influence of staphylococci and their products upon the skin of man. They found that "toxin" obtained from broth cultures, when applied to the skin, caused eczema alone; while "plasmin" from the cells of the organisms, applied to the skin, caused pus formation. Bockhart states that the inactive staphylococci in the sound follicles of the skin, due to some inner or outer condition of the body which improves their nutritive conditions, increase their activity. This results in the excretion of the toxin which diffuses into the epidermis giving rise to a serotactic action and the formation of vesicles and papules. The tissues in the immediate neighborhood of these lesions contain only clear serum and no organisms. After a time the organisms increase and invade these areas. If the organisms contain sufficient "plasmin," leukocytes wander in and the process becomes pustular.

The fact that non-virulent staphylococci from the skin can become virulent has been proved by Geisse (33). He obtained three strains which were non-virulent, non-hemolyzing, non-pigment forming, and which would not agglutinate with serum agglutinating pathogenic strains. These were placed in collodion capsules and placed within the peritioneal cavities of guinea-pigs. After a passage of three or four animals they acquired pathogenic, hemolyzing and pigment-forming properties and were agglutinated by serum specific for pathogenic strains in high dilutions.

There is no doubt that most of the skin affections are due to the staphylococci, although Weichardt and Apitzsch (14) mention isolating streptococci from the lesions of machine shop workers, and Oliver and Schwab (34) isolated from a patient having furunculosis an organism which they considered belonged to the colon-typhoid group.

## Bacteriology of Oils

A review of the literature shows that very little attention has been given to the bacteriology of oils. Deeds (19) made a bacteriological examination of oil, petroleum, and grease mixtures, and in five out of six examinations he found *Bacillus subtilis*, or air-borne bacteria, but succeeded in isolating no pyogenic organisms. He also examined these products to determine their effectiveness as a medium for bacterial

growth and as germicidal agents. A twenty-four-hour culture of *Staphylococcus pyogenes aureus* was added and the suspension allowed to stand at room temperature for ten hours. Each hour a loopful of this material was transferred to 10 c.c. of nutrient agar and plates were poured. The result of this test showed that there was neither an increase nor a decrease in the number of bacteria during that period.

Albaugh (21) reported the examination of eight samples of oils and cutting compounds procured from machines, and from which cultures were made as follows: "slants of glycerine-agar and blood-serum were treated with a loop of each sample, as were plates of glycerine-agar. At the end of twenty-four hours all of the cultures had visible bacterial growths. These were found to be the usual pus-forming organisms. One sample showed as many as 110,000 micro-organisms per gram of oil (estimated from colonies in Petri plates after incubation for thirty-six hours)—the organism being practically a pure culture of *Staphylococcus aureus*."

## Experimental Work

In the present investigation cultures were first made on plain agar, one set of plates being incubated at 25° C., and the other at 37° C. The types of organisms appearing on the plates were the same in both series. A few loopfuls of oil were suspended in agar and heated at 80° C. for twenty minutes, and plates made. No growth occurred. Eosin-methylene-blue plates were inoculated and one set incubated aërobically, the other, anaërobically over metallic phosphorus. Good growth was observed on the aërobic plates in forty-eight hours, and from these Types I and II mentioned below were isolated. Type III did not appear on these plates for several days, but gradually grew somewhat scantily. This type also grew somewhat better at room temperature than at incubator temperature. The anaërobic plates showed only Types I and II, Type I greatly predominating.

From deep agar shake cultures only Types I and II were isolated. No obligate anaërobes were obtained by any of the methods used. Cultures obtained by enriching in dextrose broth, lactose broth, and dextrose broth containing meat, all gave rise to Types I and II. Type III was evidently overgrown in these cases.

The organisms isolated were as follows: Type I, *Bacillus aërogenes;* Type II, *Bacillus coli communis;* both of fecal type as described in the Standard Methods for Water Analysis for 1917. The former gives all the typical reactions of the *Bacillus aërogenes* group, is alkaline to methyl red, gives a positive Voges-Proskauer reaction and ferments adonite. Type II gives all the typical reactions of *Bacillus coli communis*, is acid to methyl red, negative to the Voges-Proskauer reaction, and does not ferment adonite. Type III is a Gram-negative, non-spore forming, actively motile rod with an average of about twelve flagella of peritrichic arrangement. It liquefies gelatin, and digests casein and Löffler's blood serum very rapidly. It is very similar to the liquefying *Proteus vulgaris* strains, but produces neither acid nor gas in any of the fourteen carbohydrates tested. The final hydrogen ion concentration in Clark and Lubs' medium dextrose broth and peptone solution was about 8.2. It gives a negative Voges-Proskauer reaction and did not produce indol.

Tests were made of the thermal death point of these organisms suspended in normal saline solution as well as in the oil from which they were originally isolated. The mixture was drawn into capillary tubes, which were sealed at each end and placed at temperatures indicated in Table 1. At the end of the exposure the tubes were removed, placed in a 5 per cent. solution of phenol for fifteen minutes, then in 95 per

cent. alcohol for fifteen minutes, and then allowed to dry in a sterile Petri dish. The ends were then broken off with sterile forceps and the contents allowed to flow out into sterile plates to which agar was added. Table 1 shows the results obtained.

Bacteria seem to be able to retain their vitality in oil for long periods of time. The sample of oil investigated has been in this

TABLE 1.—THERMAL DEATH POINT OF ORGANISMS

| Time of Heating at 60° C. | Type I | Type II | Type III | Oil |
|---|---|---|---|---|
| *minutes* | | | | |
| 5 | + | + | + | + |
| 10 | + | + | + | + |
| 15 | + | + | − | + |
| 20 | + | − | − | + |
| 25 | − | − | − | − |
| 30 | − | − | − | − |

| Time of Heating at 70° C. | Type I | Type II | Type III | Oil |
|---|---|---|---|---|
| *minutes* | | | | |
| 5 | + | − | − | + |
| 10 | − | − | − | + |
| 15 | − | − | − | − |
| 20 | − | − | − | − |

laboratory for eight months and still contains as many bacteria as when it was received. One interesting point is that while there were typical fecal types of bacteria present in the oil, yet no spore-forming types or staphylococci could be isolated.

Kurpjuweit (35) studied the length of time that bacteria could retain their vitality in olive oil and reported the following:

| | | | | | |
|---|---|---|---|---|---|
| *Staphylococcus aureus* | not | obtained | after | 12 | days |
| *Bacillus coli* | " | " | " | 14 | " |
| *Bacillus diphtheriae* | " | " | " | 9 | " |
| *Bacillus pyocyaneus* | " | " | " | 14 | " |
| *Micrococcus ureae* | " | " | " | 11 | " |
| *Bacillus typhosus* | " | " | " | 14 | " |

Studies on the influence of desiccation in air and in vacuum were made by Hammer (36) who found that *Bacillus coli* when desiccated in air over sulphuric acid died in two days. When desiccated in vacuum it lived for fifty-seven days (end of test). *Staphylococcus aureus* gave no growth in two days in air and growth after fifty-four days in vacuum. *Bacillus pyocyaneus* gave no growth after four days in air, nor after seventeen days in vacuum.

In the present investigation, tests were made to determine the length of time these organisms would retain their vitality upon the ordinary artificial media. The results are shown in Table 2.

*Pathogenicity.*—One c. c. of a forty-eight-hour broth culture of these organisms was injected intraperitoneally into guinea-pigs of the following weights: Type I, 564 gm.; Type II, 509 gm.; Type III, 539 gm. The pig receiving Type I was dead in twenty-four hours and a pure culture of the organism was obtained from the peritoneum, liver and heart blood. The animals receiving Types II and III showed no ill effects,

TABLE 2.—LENGTH OF TIME ORGANISMS RETAIN VITALITY UPON ARTIFICIAL MEDIA

| Culture Medium | 32 Days | | | 60 Days | | |
|---|---|---|---|---|---|---|
| | Type I | Type II | Type III | Type I | Type II | Type III |
| Litmus milk | + | − | + | − | − | + |
| Dextrose broth | + | − | + | + | − | + |
| Peptone solution | + | + | + | + | + | + |
| Agar slant | + | + | + | + | + | + |

excepting that the Type II pig appeared sick for about forty-eight hours.

*Relation of Organisms Isolated to Furunculosis.* — The particular sample of oil in question was submitted to this laboratory as it was considered to be the cause of boils. All attempts to isolate pyogenic organisms failed, and since the oil was drawn directly from the supply barrel and was not exposed to dust, it is doubtful if any of these or-

ganisms were present. As it is well known that the ordinary staphylococcus types are quite highly resistant to external conditions, it is also doubtful if they would have disappeared and left the colon type in such large numbers and such vigorous condition. It is indeed difficult to understand how such tremendous numbers of organisms of the type isolated could have been present in the oil without direct fecal contamination.

From our tests the oil could not be incriminated directly as being the cause of the disease. The tests are, nevertheless, of considerable significance in showing how long organisms can live in oil and still retain their virulence. We may here again emphasize the point so often mentioned by others, that workers should use great care not to contaminate the oils which are to be used again, and not to use waste and rags with which others have wiped their hands.

### Treatment of Oil to Reduce Danger of Infection

It does not necessarily follow that infection of the skin will result from the use of oil contaminated by pus-forming bacteria. As was mentioned in the first part of this article, certain oils are naturally somewhat irritating to the skin, while others may contain particles of metal which cause injury. Also, some individuals are predisposed to infections of this type. In order to eliminate possible danger of infection, therefore, the oil should be handled with precaution. The workmen should be warned against spitting into it since pyogenic organisms are very common in the mouth and saliva, and persons with skin affections of any kind should not be allowed to come in contact with the oils or cutting compounds used by others. The heating of the oil to 70° C. for twenty or thirty minutes will destroy all the dangerous types of bacteria, and by allowing it to stand for a short time the particles of metal will settle out and may be discarded. The individual cleanliness of the worker himself and the care of his hands will also reduce the danger of infection.

Boils cannot be entirely eliminated, however, especially in those who are predisposed to irritation, and whose skins are little resistant to the irritating action of oil and bacterial invasion, since organisms of the type commonly causing boils are very common on the skin. Thus, irritation or injury merely aids their entrance.

### Summary

1. Oils of all types are likely to produce skin affections if they come in contact with the skin for some length of time.

2. The most serious skin diseases are probably due to the oil acting as a carrier of infectious material from one individual to another.

3. Individuals of the most cleanly habits are, generally speaking, least liable to skin affections due to oils.

4. Special care should be exercised by workmen on cutting machines to avoid contamination of the oil, especially by spittle.

5. Individuals having skin diseases should be transferred to some other type of work.

6. While oils may be placed on the market in a sterile condition and free from dust, etc., they will not long remain so after being put into use.

7. By heating the oil to 70° C. for twenty or thirty minutes, it is possible to destroy all the dangerous pathogenic bacteria likely to be present.

8. It would seem very desirable to use oil which has been rendered free from dust, and especially from particles of metal.

9. Workmen should not exchange waste and rags used in cleaning their hands, and should not bathe their hands in the oil.

10. Clothing saturated with oil should not be worn, especially if there is an epidemic of skin diseases among the workers.

*Note.* — After this paper was accepted for publication, the *Editor* called the attention of the writers to the report of an investigation by the research staff of E. F. Houghton & Company on the *Causes of Skin Sores and Boils among Metal Workers* (37). Data are given in detail and the results of the investigation are summarized in non-technical language. These results show:

1. Ichthyol (0.2 per cent. to 1 per cent.) contained in certain oils produces skin lesions.

2. The oils pressed from crude solid paraffin also contain an irritating substance.

3. Lard oil does not irritate but may contain bacteria.

4. Houghton's non-irritating blending oil is almost entirely free from ichthyol and from organically combined hydrocarbon sulphonate. It is free from paraffin wax and contains no other ingredients which would irritate the skin.

5. Daily filtration of used oil (140° F. for thirty minutes) combined with sterilization will reduce the number of metal particles and the danger of bacterial contamination from careless workmen.

6. Germicides added to oil are not efficient or satisfactory.

7. The cleanliness of the worker is of first importance. Education in cleanliness is needed.

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# BOOK REVIEWS

**Public Health and Insurance: American Addresses.** By Sir Arthur Newsholme, K.C.B., M.D., F.R.C.P., Lecturer on Public Health Administration at the School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland; Late Principal Medical Officer of the Local Government Board, England; President of the Society of Medical Officers of Health and of the Epidemiological Society; Examiner in Public Health to the University of Cambridge, in Preventive Medicine to the University of Oxford, and in State Medicine to the University of London, Member of the General Medical Council, of the Council of the Imperial Cancer Research Fund, etc. Cloth. Pp. 270 with index. Baltimore: The Johns Hopkins Press, 1920.

In the form of ten lectures Sir Arthur Newsholme has brought together material presented by him in addresses to various public audiences in the United States and Canada, and particularly to students in the School of Hygiene and Public Health of Johns Hopkins University during the year 1919–1920. It is fortunate that there are thus made available to a larger public these expressions of the philosophy and wisdom of an able and broad-visioned public health administrator.

The lectures are concerned essentially with the development of public health activities in England, and it is, therefore, inevitable perhaps that there should be extended discussion of the relation of public health administration to the Poor Law authority and of the interrelations of poverty and disease.

Dr. Newsholme's views regarding the English National Insurance Act would undoubtedly interest any person who has given thought to the problems of compulsory health insurance. "The chief justification of a national system of insurance against sickness is that it shall be an action auxiliary in the prevention of disease. . . . Health progress can only be secured by preventing preventible illness. . . . In securing such a result there will be needed medical practitioners who are imbued with the ideas of preventive medicine in its widest sense. . . . There is needed a reconstruction of the training of each medical student which will make preventive medicine in its widest sense an integral part of his training. . . ."

This very readable book well merits the attention of all who believe that "the real wealth of a nation does not consist in its money, in the volume of its trade, or in the extent of its dominion. These are only valuable in so far as they help to maintain a population — and not only a portion of it — of the right quality: men, women, and children possessing bodily vigor, alert mind, firm character, courage, and self control"; and that "this ideal can never be realized unless and until the medical men of the future train themselves for and devote themselves to their essential share in its fulfillment." — *Wade Wright.*

**Die Kohlenoxydvergiftung. Ein Handbuch für Mediziner, Techniker und Unfallrichter.** By Professor Dr. L. Lewin. Paper. Pp. 369 and a spectroscope chart. Berlin: Julius Springer, 1920.

This book is by the well-known Berlin toxicologist, who has written many articles on carbon monoxide poisoning in current medical literature. The subject is dealt with exhaustively under the following headings: history; sources of carbon monoxide; physical and chemical properties; relation of carbon monoxide to the tissues of the body; qualitative and quantitative tests; mode of action on plants, cold-blooded and warm-blooded animals; rôle of individual susceptibility in poisoning; mode of absorption; sources of carbon monoxide in industry; acute poisoning and its sequelae; chronic poisoning; pathological anatomy and medico-legal aspect; statistics; prophylaxis and treatment.

The chapter on history opens with the statement that carbon monoxide is now and has been since the first discovery of fire the most widespread poison connected with human life and activity. Aristotle mentions coal gas as a cause of death. Livy and Valerius Maximus describe wholesale executions performed by imprisoning the victims in the public baths and then starting the fires, and it seems also to have been a common method of painless suicide in Roman days. Julian, the Apostate, describes a very typical case of poisoning which he suffered when sleeping in a room with a pan of glowing coals. Through the Middle Ages the history of carbon monoxide poisoning passes from one extreme to the other. Sometimes its effect is attributed to the work of demons or witches; again, an unusually observant and clear-headed physician will describe a case with great accuracy. Avicenna noted it as a poison which weakened the brain. Toward the latter part of 1500, Donato of Mantua described practically all the symptoms of this form of poisoning, the rosy color of the face and the appearance of nor-

mal sleep in the coma of carbon monoxide victims, the fever, bronchial irritation, and pneumonia which follow, and the different manifestations of damage to the brain. More than a hundred years later, Ramazzini described carbon monoxide as a common industrial poison, and the eighteenth century saw the publication of several very accurate observations, notably those of Friedrich Hoffmann in 1720 and of Boerhave in 1732.

The author gives analyses of smoke and gas from all possible sources, and the student who wishes to look up "gassing" in mines, in the use of explosives, in blast furnace work, in the use of power gas, and in the manufacture and use of illuminating gas will find much valuable material here. In the section on the physical and chemical properties of carbon monoxide, Lewin warns against the fallacy of applying to human beings the facts discovered in the laboratory, for in this form of poisoning, more than in any other, individual characteristics play an enormous rôle. The outcome of no single case can be predicted on the findings with regard to concentration of carbon monoxide or absence of oxygen; the man's fate lies essentially in his own vital forces. Even the capacity of the blood to bind carbon monoxide varies in different individuals. A practical point brought out by test tube experiments is that, although the blood gives up carbon monoxide even at zero centigrade, the surrender is much more rapid at a higher temperature.

It is impossible to cover nearly all the chapters of this book within the compass of a review. There is space only for the stand taken by Lewin on various controversial points. He finds carbon monoxide excreted very rapidly during the first hour after removal to fresh air, then more slowly, but by the end of six hours it is usually no longer demonstrable, although he has satisfied himself that as little as 0.25 per cent. can be shown through the spectroscope. He is very skeptical about the instances reported in the literature of carbon monoxide in the blood after more than twenty-four hours in pure air. The great variation in the quantity found in the blood after death (from 6 per cent. in Emile Zola's blood to 83 per cent. in one of Haldane's cases) can only be explained on the ground of individual susceptibility or perhaps of difference in the mode of administration of the gas, or the possibility that blood in different parts of the body contains different proportions of carbon monoxide.

Lewin takes a very positive stand in the controversy over the mode of action of carbon monoxide, denying that there is any direct action on the cells of the central nervous system or of any other organs. All the manifold lesions found after carbon monoxide gassing result from the injury caused by oxygen privation. The whole error of those who uphold the theory of carbon monoxide as a protoplasmic poison is that they do not distinguish between the lesions of acute poisoning and the later results which have no direct connection with the intoxication but are secondary and of various origins. It is absurd to say, when pneumonia supervenes twenty-four to forty-eight hours after the intoxication, that carbon monoxide has injured the lung, for it has no chemical or physical effect on lung tissue nor does it injure the blood vessels, producing fatty changes of intima and media, any more than does the inhaling of amyl nitrite. Carbon monoxide poisoning is a special kind of asphyxia which in general corresponds symptomatically with other forms of oxygen deprivation. This statement rests on the blood changes noted and on the impossibility as yet of finding any other tenable theory. If the blood changes are not the essential and only cause, then the action of carbon monoxide on the brain must be relegated to the mysterious realm of morphine, hydrocyanic acid, cocaine, etc., which have nothing in common chemically and yet affect the function of the brain in some unexplained way. With carbon monoxide as with hydrogen sulphide and with the poisons which form methemoglobin, there is a *causa proxima* in the blood changes, and this should be accepted so long as no more cogent cause can be found.

Carbon monoxide poisoning is, however, distinguished from all other oxygen-deficiency or hemoglobin-alteration poisons by the occurrence of sequelae. In all toxicology no known body can compare with carbon monoxide in the variety and extent of lesions following it, and individual susceptibility is not enough to account for them. But to assume that carbon monoxide acts directly on the brain and other organs does not help, for in that case the effects would be more uniform and constant. Their great variation and extent show that very special conditions must be present, not accounted for by mere oxygen deficiency or other poisons, and it is these conditions that are the most puzzling elements in the problem of carbon monoxide poisoning.

To the unsettled question of chronic carbon monoxide poisoning Lewin does not contribute very much, although he gives some instances of marked and undoubted slow poisoning. It cannot be regarded as a cumulative effect of the gas in the body which, when it reaches a certain degree, gives rise to clinical symptoms. For this, one would have to remain in the carbon monoxide atmosphere continuously, and that is never true; one is always getting rid of the gas when one goes out into pure air. A chemical accumulation cannot occur, but a functional one can — *i. e.*, a cumulative effect of all the injuries done to the blood and to the tissues, especially the hemopoietic. This injury may be simply nutritive — an anoxemia — but as a result poisonous products may be formed and exert their own secondary action. As in acute poisoning, individual susceptibility varies greatly. There is great difficulty in diagnosis, for the symptoms are usually only headache, anemia, cardiac neurosis, or general nervousness. The avocations in which this danger is present are these: cooks, furnace tenders, pressers, laundry workers, gas workers, molders, miners, chemists, firemen, garage workers and housewives. The symptoms which come on usually at the end of the day's work — headache, dizziness, and disturbance of vision — pass over quickly at first in the open air, but later the natural recuperative powers fail and some form of chronic poisoning sets in, the most common of which is anemia, which may be of any type up to the severe pernicious.

The treatment of acute carbon monoxide poisoning must be directed toward the restoration of normal response to stimuli on the part of the cerebral centers, especially the respiratory. The ground for administering oxygen is the fact proved by experiment that the dissociation of carbon monoxide from the blood takes place five times as quickly with pure oxygen as with ordinary air. The administration must sometimes be prolonged, but it is necessary to remember that with the disappearance of carbon monoxide from the blood the symptoms caused by its presence do not always disappear. The brain symptoms, for instance, may not improve, even after all the carbon monoxide has vanished, and one must assume either that there are other toxic substances present in the blood which continue to act, or that the degenerative changes set up by carbon monoxide progress after the cause has been removed. Lewin condemns unreservedly the subcutaneous injection of oxygen or hydrogen peroxide. He approves of venesection as lessening the danger of hemorrhage, stimulating blood regeneration, and also as effecting a partial removal of the poison (*Teilentgiftung*), which last is hardly in harmony with his repeated assertion that carbon monoxide is not a poison. Normal salt infusion is of decided value, especially when preceded by bleeding, but Lewin objects strenuously to blood transfusion, apparently under all circumstances.

A colored chart of the different spectra of oxyhemoglobin and carbon monoxide hemoglobin before and after reduction is appended. The bibliography is very full, in fact, practically complete except for the more recent American publications which were probably not accessible to the author at the time of writing. — *Alice Hamilton.*

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# PHYSIOLOGICAL EFFECTS OF AUTOMOBILE EXHAUST GAS AND STANDARDS OF VENTILATION FOR BRIEF EXPOSURES *

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## INTRODUCTION

THE increasing use of the gasoline engine in a widening diversity of fields has brought with it corresponding problems concerning the influence of exhaust gases upon the health not only of the men in immediate charge of the machines but of the general public as well. Reports upon a number of these problems have already been published by the United States Bureau of Mines, but, for the most part, recent studies have dealt particularly with the use of traction engines and the vitiation of the air in coal mines, and the determination of standards for the allowable vitiation requisite for safety.

The plan to construct tunnels under the Hudson River between New York and Jersey City for the use principally of motor vehicles has raised several problems which have previously, however, never been extensively investigated. Whereas the conditions in coal mines and about gas producer plants apply only to healthy men, the conditions which will prevail in the tunnel under the Hudson River will affect the general public. Not only healthy adults but children and even invalids on their way to hospitals will be transported through it, and at some time it may be necessary for soldiers to march through. The amount of traffic is likely to be large, even from the beginning, and is likely to increase in a few years to the maximum capacity of the roadway. The total amount of exhaust gas discharged from passenger cars and trucks will therefore be considerable. The distance between

* An abbreviation of the report to the Chief Engineer of the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission. The investigations were carried out under the Bureau of Mines at the Physiological Laboratory of Yale University. The full reports on both the engineering and the physiological aspects of this problem will be published in the report of the Chief Engineer of the Commissions and by the Bureau of Mines. Published here by permission of the Director of the U. S. Bureau of Mines and of the Chief Engineer of the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission. Received for publication Feb. 24, 1921.

the ventilating shafts at the pier heads on the two sides of the river will be somewhat more than 3,300 feet — a distance greater than in any existing tunnel used by motor vehicles — and the total length of the tunnel about 8,500 feet between portals. The ventilation must, therefore, be ample to prevent not only danger, but even slight discomfort, and must be managed in such a fashion as to avoid excessive wind velocities. The cost of installing ventilating fans will, in any case, be an appreciable item in the initial construction, and the maintenance of artificial ventilation during the operation of the tunnel is likely to be one of the largest single items of continuing expense.

Accordingly, the commissions of the states of New York and New Jersey through their Chief Engineer, Mr. Clifford M. Holland, contracted with the Bureau of Mines to undertake on their behalf the investigation of two problems: (1) the amount and character of the exhaust gas produced by various types and sizes of passenger cars and trucks; and (2) the nature of the toxic substances in exhaust gas, and their allowable concentration — that is, the extent to which the gas must be diluted with air to become practically harmless. The results of these two investigations will together afford the data upon which plans and designs for the ventilation of the tunnel may be intelligently based.

Problem 1 was placed in the immediate charge of Mr. A. C. Fieldner, supervising chemist of the Bureau of Mines at the Experiment Station of the Bureau at Pittsburgh. Problem 2, of which the results are here published, was assigned to Dr. Yandell Henderson, Professor of Physiology in Yale University and Consulting Physiologist of the Bureau of Mines. The work was carried out by him with a staff of physiologists and chemists employed by the Bureau for this purpose in the Physiological Laboratory at Yale University.

The investigations and formulations here presented are of a much wider scope than the mere solution of the problem raised by the Hudson tunnels. Vehicular tunnels are being very generally considered both as substitutes for bridges and as a means of decreasing distances and grades in highways in mountainous regions. Furthermore, the results of these investigations apply almost equally well to conditions in garages and fire rooms, to the air around gas producers, smelters and blast furnaces, to dwellings in which there is an escape of illuminating gas, and, in general, to all places where men are exposed to the gaseous products of incomplete combustion.

Prior to this investigation, the standards of allowable air vitiation with carbon monoxide have not been precisely defined. The investigations of Dr. J. S. Haldane, the eminent English authority, have dealt chiefly with questions of the safety of miners after mine explosions and fires, and his attention has, therefore, generally been directed to the amount of carbon monoxide which would incapacitate or seriously inconvenience a man, rather than to those amounts which are compatible with complete comfort and efficiency. For the London underground railways, however, he gave it as his opinion that a concentration of not more than one part of carbon monoxide in 10,000 of air was desirable. It is noteworthy, nevertheless, that he contemplated a possible period of exposure sufficient for the blood to approach equilibrium with this concentration in the air. The standard hereinafter proposed by the authors appears at first sight distinctly higher than that originally suggested by Dr. Haldane, but when the short time of exposure in the proposed vehicular tunnels is taken into consideration it will be seen that the figures reached by Dr. Haldane and by the authors for the amount of carbon monoxide absorbable without appreciable injury or discomfort are in quite close agreement.

It might appear that the ventilation of any closed space should be such as to furnish virtually as pure air as that of the city streets. In that case, this investigation would be unnecessary, and a standard of not more than one part of carbon monoxide in 10,000 of air might have been adopted. To have attempted, however, to ventilate long tunnels like those under the Hudson River, or any similar closed space, so that the air would be virtually free from carbon monoxide, would perhaps have proved scarcely practicable. It would certainly have been extremely expensive. The wind velocities necessary in moving such a volume of air would cause discomfort to passengers and might even prove prohibitive of traffic.

The standards here established will reduce the expense of ventilation greatly below that required to provide a carbon monoxide dilution of one to 10,000, not only in the Hudson tunnels, but in all similar future undertakings. These standards will, it is hoped, prove valuable both to hygienists interested in safeguarding the public health and to engineers engaged in the design of a wide variety of projects both above and below ground.

## I. Fundamental Considerations

Although carbon monoxide is the cause of more deaths than the total due to all other gases, apart from a single reaction it is a physiologically inert and non-poisonous substance. This reaction is its combination with hemoglobin, the red coloring matter and oxygen-carrying element of the blood. To whatever extent hemoglobin is so combined, it is rendered incapable of transporting oxygen from the lungs to the tissues and organs of the body, until the carbon monoxide is again displaced. It is highly probable that all of the results of inhalation of carbon monoxide are due directly or indirectly to oxygen deficiency. Even when other toxic substances are present — as in smoke, in fumes from explosives and in other incomplete combustions — carbon monoxide is usually the chief cause of injury or death. It acts wholly through asphyxia.

The body of an adult man of average weight contains enough hemoglobin to hold about 600 c.c. of oxygen. If completely saturated, it would hold the same amount of carbon monoxide, one molecule of carbon monoxide replacing one molecule of oxygen in the blood. The absorption of 6 c.c. of carbon monoxide from the lungs produces, then, 1 per cent. of saturation and abolishes 1 per cent. of the oxygen capacity.

The unit, in which various concentrations of carbon monoxide are commonly measured and expressed for purposes of ventilation, is one "part," or a certain number of "parts," of this gas mixed with 10,000 times as much air. A "part" is a hundredth of 1 per cent. of an atmosphere. A man at rest breathes about 8,000 c.c. of air per minute, of which about 6,000 c.c. reach his lungs, or 60 liters in ten minutes. Let us suppose that this air contains one part of carbon monoxide, or 6 c.c. in 60 liters, and that all of this 6 c.c. is absorbed. The blood would then become saturated at the rate of 1 per cent. every ten minutes per "part" of carbon monoxide in the air. Evidently the duration of exposure is a limiting factor in the amount absorbed, for one cannot absorb more than one inhales.

It appears that when a man begins breathing any low concentration of carbon monoxide mixed with air, absorption at very nearly this rate does occur, but only at first. Then the rate becomes slower. Even if the exposure is prolonged, carbon monoxide merely displaces oxygen from the blood up to a point of equilibrium depending upon the relative amounts, or mass actions, of carbon monoxide and oxygen in the air breathed and the intensity of the affinities of the two gases for

hemoglobin. If thereafter the pressure of oxygen is high enough and that of carbon monoxide is low, or absent as in pure air, oxygen can likewise displace carbon monoxide and thus completely restore the oxygen-carrying power of the hemoglobin. The blood is neither directly changed nor injured by the process.

Hemoglobin attracts carbon monoxide about 300 times as strongly as it does oxygen. Thus, if $T_{O_2}$ and $T_{CO}$ are the pressures of oxygen and carbon monoxide, and $Hb_{O_2}$ and $Hb_{CO}$ the amounts of oxyhemoglobin and carbon monoxide hemoglobin in the blood, the relations are expressed by the formula:

$$\frac{T_{O_2}}{T_{CO} \times 300} = \frac{Hb_{O_2}}{Hb_{CO}}, \text{ or}$$

$$\text{percentage } Hb_{CO} = \frac{T_{CO} \times 300}{T_{O_2} + (T_{CO} \times 300)};$$

or more specifically, if there are 1,500 parts of oxygen and 2 of carbon monoxide, the formula works out to:

$$\frac{2 \times 300}{1500 + (2 \times 300)} = 28.5 \text{ per cent. saturation with carbon monoxide.}$$

The air in the lungs contains about 1,500 parts of oxygen in 10,000. (It is actually somewhat less than 15 per cent. of oxygen. The affinity of hemoglobin for carbon monoxide may also be less, or more, than 300. We are here using round numbers merely to illustrate the principle without attempting mathematical precision.) We may calculate the blood equilibrium for any concentration of carbon monoxide in the air, and from such data we may obtain the carbon monoxide dissociation curve of the blood as shown in Figure 1. This curve indicates that, if air containing two parts of carbon monoxide in 10,000 is breathed for a time long enough to attain equilibrium, the blood should become about 28 per cent. saturated; with four parts, 44 per cent.; with six parts, 54 per cent.; and so on. In the curve it is to be seen that, for instance, the equilibrium value for ten parts of carbon monoxide in 10,000 of air is 66.6 per cent. saturation, which is a sufficient degree of saturation to render a man unconscious and totally helpless. If continued, the asphyxia might lead to serious permanent injury or even death.

The question of greatest practical importance is: How long a time would be required to attain this or any other definite percentage of saturation? In other words, what is the physiological law defining the rate of absorption of carbon monoxide into the blood? From the simple calculation, given previously, regarding the oxygen capacity of the body and the volume of air drawn into the lungs, it appears that a man breathing ten parts of carbon monoxide would inhale enough of the gas to become 66.6 per cent. saturated in 66.6 minutes. But, as already indicated, the more carbon monoxide the blood contains, the greater becomes the force with which this gas tends to diffuse out again into the air. The more nearly this tendency equals and counterbalances the pressure of the gaseous carbon monoxide in the lungs, the slower the absorption of more carbon monoxide becomes. Thus, to attain a condition of complete blood equilibrium many hours would be actually required; indeed, the time is indeterminate. Doubtless other factors also play a part in retarding and stopping absorption.

It appeared to us, however, that *a definite quantity for determination would be the time required for attainment of a percentage saturation of one-half the equilibrium values.* Thus, in an atmosphere containing two parts of carbon monoxide, for which the blood equilibrium is about 28 per cent., how long a time would be required for the blood to become 14 per cent. saturated? How long with four parts and an equilibrium value of 44, to attain 22 per cent. saturation; or with six parts and an equilibrium of 54, to reach 27 per cent.? The answer to

this question is the principal practical contribution to knowledge which we have to make — namely, that *the time for attainment of half equilibrium for persons sitting at rest and breathing concentrations of carbon monoxide up to seven parts is never considerably less than one hour.* This fact is, we believe, of fundamental importance for ventilation engineering. We have established it purely experimentally. It might, however, easily be correlated with the oxygen consumption and the carbon dioxide elimination, but we have not thought this to be of practical importance to the immediate object of this report. It does not, nor does it aim to, express what the average person does under the conditions, for many of our subjects fell much below this rate of absorption. The value of the rule is that it expresses the worst attainable, or, so to speak, the "maximum load."

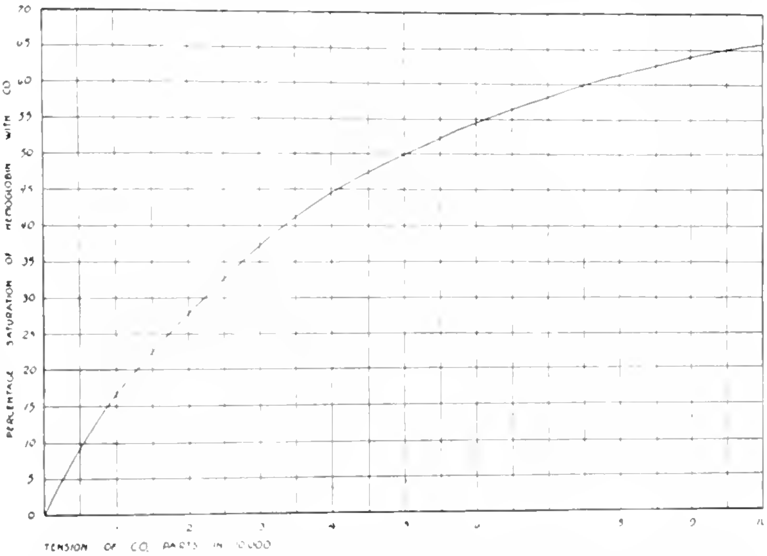


Fig. 1. Final or equilibrium distribution of hemoglobin between carbon monoxide and oxygen when various low concentrations of carbon monoxide in air are inhaled for an indefinitely long time.

We may here conveniently consider the question, often raised, of possible extreme individual susceptibility. Such susceptibility might conceivably arise (1) from anemia, that is, a subnormal amount of hemoglobin; (2) from an unusual avidity of the individual's hemoglobin for carbon monoxide; (3) from unusual susceptibility to the ill effects of oxygen deficiency; or (4) from a volume of breathing much above the ordinary. The first is unimportant practically inasmuch as anemics need not spend long periods in ill-ventilated garages, nor ride through tunnels on slow moving trucks. If, however, they are transported at the speed of a passenger car or an ambulance through a two-mile tunnel containing the average concentration of carbon monoxide here to be proposed, the time of exposure will be too brief to allow an absorption sufficient for any considerable ill effect. The second possibility has been investigated by us, but has not been found to occur. (Owing to their highly technical and space-consuming character, these studies are omitted here, but will appear in the full report.)

There is reason to believe that there are individual differences in the degree of the ill effects induced by considerable oxygen deficiency. Aviators and mountain climbers exhibit such differences, and in our more extreme tests headache has occurred in some persons at a somewhat lower percentage saturation of the blood than in others. We have, however, found no one who experienced this effect — the first sign of oxygen deficiency — under the conditions of the standards which we shall propose.

The volume of breathing is by far the most important element in the rate of absorption of carbon monoxide and, thus, in the individual variations in the ill effects of inhalation of this gas. In general, the expired air of a healthy man contains 4 or

5 per cent. of an atmosphere less oxygen than the inspired air, and this percentage deficit is nearly the same during rest with a breathing of 8 liters and under physical exertion with a respiration several times as large. In other words, the volume of breathing is roughly proportional to the amount of the oxidation and energy liberation occurring in the body. In our observations, persons of vigorous physique and large breathing rates have absorbed carbon monoxide much more rapidly, as measured in percentage blood saturation, than those of more sedentary habit and delicate physique. As the standard which we shall propose is one adjusted to protect even the strong, it will therefore afford an extra safeguard to the weak and sick, who breathe little (except in febrile cases) and who would, accordingly, absorb carbon monoxide comparatively slowly. Only in the case of children, whose active vitality involves a relatively large food and oxygen consumption and a corresponding volume of breathing, will this rule probably not hold. But even for the most active child, a period of exposure of only ten or fifteen minutes to the concentration of carbon monoxide here approved will not be long enough for any considerable absorption of the gas.

The particular problem before us — that of a standard for the ventilation of the proposed vehicular tunnels under the Hudson River — may, therefore, be thus simply expressed: What percentage saturations of the blood with carbon monoxide cause appreciable discomfort in healthy men sitting at rest, and what percentage saturations do not? The answer to this question, the probable duration of exposure of passengers through the tunnel, and the law of carbon monoxide absorption as above stated, are the three considerations on which any sound standard must be based.

In view of the foregoing discussion it is, we trust, clear that standards of concentration, which will adequately protect men exposed for the greater part of an hour, will afford an enormous factor of safety for persons inhaling the vitiated air for only ten or fifteen minutes. We are informed by the engineers that all traffic through the tunnels will be in two distinct classes — namely, passenger cars, which will make the trip in ten or twelve minutes, and trucks which may take as long as thirty-five or forty minutes. The standards which we set ourselves to work out are such as will afford not only absolute safety but also complete freedom from any trace of discomfort for healthy and vigorous adults exposed for periods of forty-five to sixty minutes.

## II. Experiments on Men in Six Cubic Meter Chamber

The method of studying the effects of various concentrations of carbon monoxide upon which we have chiefly relied for establishing our standard is illustrated in Figure 2. It involves a chamber of 6.4 cubic meters, or 226 cubic feet, capacity, the walls and door of which are covered with galvanized sheet iron with soldered joints. The door is easily made gas-tight by placing long strips of broad (2-inch) adhesive plaster over the cracks along lintel, jambs, and sill. The chamber holds any concentration of gas for a day without appreciable loss from diffusion through undiscovered leaks. A small hole in the door, covered by a piece of adhesive plaster, allows the hand of the subject to be thrust outside for the withdrawal of blood.

Into this chamber are introduced measured amounts of pure carbon monoxide, made by dripping formic acid into strong sulphuric acid and distilling it by gentle heat into a large bottle filled with water, which the gas displaces. The concentration of gas desired in the chamber is obtained by running into the bottle 640 c.c. of water per

part of carbon monoxide desired, and thus displacing this volume of gas from the bottle through a tube into the chamber. An electric fan in the chamber insures immediate and complete mixing. In our experiments, two checks on the concentration of gas in the chamber were obtained: (1) by analysis of the carbon monoxide, before it was introduced, by means of a modified Orsat apparatus, and ignition with an electrically heated platinum spiral; and (2) by analysis of a mixed sample of the air from the chamber by the iodine pentoxide method, or by means of diluted blood. (For a description of these analytical methods, see bibliographical references 1, 2, 3.)

In this chamber, in turn, the members of the staff of this investigation and a few other persons spent periods of one hour after amounts of carbon monoxide from two to eight parts, and in one case ten parts, had been introduced. While the subjects sat and read most of the time, there were a sufficient number of acts—such as turning on the electric fan, standing up to look out of the window for a moment, opening and closing flasks to take air samples for later analysis, etc. — to correspond fairly well with the activity of the driver of a car. When we speak of the absorption of carbon monoxide by a person "sitting at rest," the condition must, therefore, be understood as only such moderate rest as this.

Blood, to the amount of twenty or thirty drops, was drawn from a finger before the subject entered the chamber; and 0.02 c.c. were drawn at the middle of the period and at the end, and usually once or twice during the next three hours. These blood samples were analyzed for carbon monoxide by the carmine method (3).

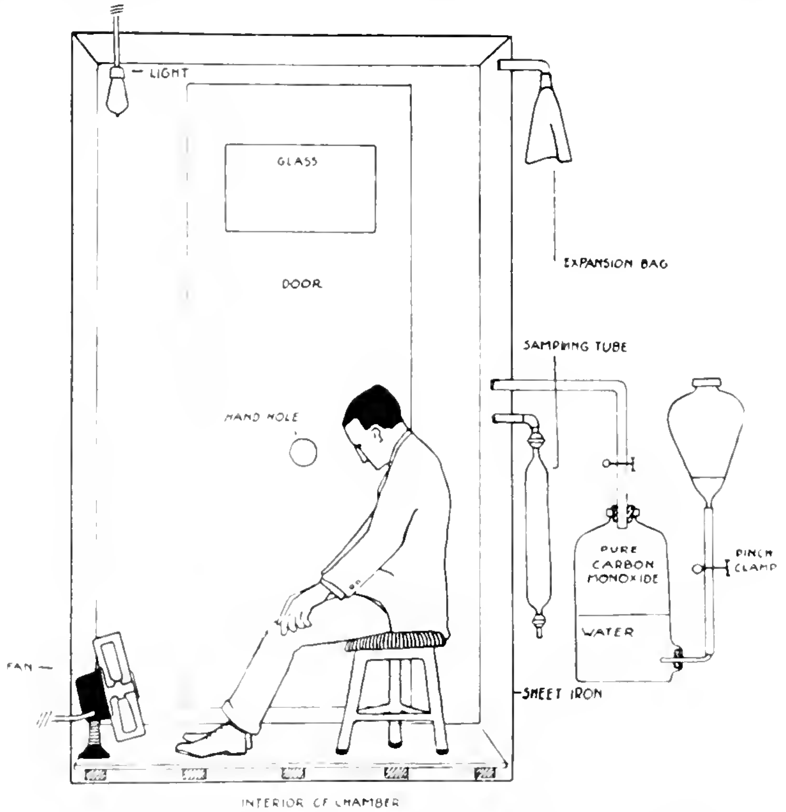


FIG. 2. Six cubic meter chamber and apparatus for introducing measured amounts of carbon monoxide. This chamber consists of a wooden framework covered with sheet iron. It contains a chair, table, and electric fan. It can be hermetically sealed by applying long and broad strips of adhesive plaster over crevices between the door and the chamber walls. The hand hole in the door is also sealed by plaster. Through this hole the subject may thrust his hand when samples of blood are required for analysis.

With the diffusion fan running, measured quantities of water are introduced into the funnel. By opening the pinch clamps carbon monoxide is displaced from the bottle into the chamber. Samples of air for analysis may be withdrawn from the chamber by means of the sampling tube. A rubber bag allows for expansion or contraction of the chamber air with changes of temperature.

After the subject had been out of the chamber for a few minutes, the tension of carbon monoxide in his lungs, supposedly in equilibrium with the blood, was determined by breathing back and forth several times, during twenty to thirty seconds, into a rubber bag. Football or basket ball

"bladders" were used for this purpose. (A series of check determinations on four subjects showed that the maximum concentration of carbon monoxide from these bags was reached in five rebreathings during thirty seconds.) This air was then analyzed for carbon monoxide by the iodine pentoxide method, or by the blood carmine method. The subject's volume of resting breathing was determined either in or outside of the chamber by means of a mouthpiece, nose clip, double valves, and Douglas bag and gas meter; and the volume per minute was calculated.

In some experiments the respiration was increased by exercise, and the increase was measured and correlated with the correspondingly greater absorption of carbon monoxide. In these experiments the subjects did "stationary" walking or running in the chamber by lifting the feet and stamping. The exertion involved is considerable, but with care it can be kept quite uniform for half an hour at a time. The pulse was counted in the chamber, and before and after the test. The effects on the pulse and respiration of running up and down four flights of stairs, each 12 feet vertically, were also determined before and after the period in the chamber.

In a few cases the retinal fields were determined and plotted. With the degrees of anoxemia occurring in these experiments, however, the effects on vision in this respect were unimportant. The Romberg test, the ability to stand erect with eyes closed without wavering, was also used, and in some cases, after an hour in eight parts of carbon monoxide, it showed marked loss of equilibrium.

But of all signs and tests, both in the experiments in the small chamber here under discussion and in those that are to be described in the next section, the typical carbon monoxide, or oxygen deficiency, headache proved most definite and reliable. It is a distinctly localized pain, usually frontal, throbbing, intensified by lying down or by exertion. It is sometimes accompanied by more or less nausea, readily increasing to vomiting. The mind is not clear, except with an effort, and one's surroundings seem a little strange. The temper is easily upset, very much as in alcoholic intoxication, and the judgment is likely to be bad. There are wide variations in the degree of this headache, but in the experiments discussed in this section it was never extreme. On the border line it verged merely into slight lassitude. As a criterion of the effect of carbon monoxide, however, it is more distinct than any artificial test. Concentrations of gas too weak and periods of exposure too short to induce this sign in anyone may be considered entirely harmless.

From Table 1, in which the data of thirty-two experiments performed in this way on nine men and one woman are given, it appears that no one had an appreciable degree of headache after a period of one hour in the chamber with four parts of carbon monoxide or less, and that with six parts the effect, if any, was usually very slight. With eight parts there was decided discomfort for some hours, although not enough to interfere with efficient work in the laboratory or at the desk. After an hour in ten parts even an unusually resistant subject was rather miserable and averse to work for five or six hours, and could still recognize the effects after twelve hours. Examination of these data enables us to reach a working rule regarding the rate of absorption of carbon monoxide, for we find that up to and including concentrations of six parts of carbon monoxide in 10,000 of air the figures in column 3 of Table 1 do not exceed values of about one-half those for complete equilibrium given in Table 2 and drawn in Figure 1.

In other words, during one hour sitting at rest in such atmospheres, a man's blood never absorbs appreciably more than half

the amount of carbon monoxide which it would take up if he stayed in the atmosphere indefinitely. Inactive and small breathing persons absorb less. At concentrations of eight and ten parts of carbon monoxide the figures deviate slightly from this rule, but the rule of half saturation appears to be safe and convenient up to seven parts. It appears further that a man who exercises sufficiently to double the volume of breathing absorbs as much carbon monoxide in half an hour as he does at rest in one hour. We have found in other experiments, which need not be given here in detail, that when walking fast a man breathes about twice as much air as when sitting still and that when hurrying or doing rather heavy manual labor he breathes about three times as much, and under exertion even more. These figures may be directly applied to conditions as they occur in regard to absorption of carbon monoxide. The estimation of the time required for half equilibrium must be shortened accordingly.

*Elimination of Carbon Monoxide.* — As regards the elimination of carbon monoxide after gassing, our data show that the process is not complete until one or two hours, or even longer, after return to fresh air. Roughly, the rate of elimination is 30 to 50 per cent. per hour, depending doubtless on bodily activity and the volume of fresh air breathed. This evidence is summarized in Figure 3.

TABLE 1. — PHYSIOLOGICAL OBSERVATIONS ON MEN IN SIX CUBIC METER GASSING CHAMBER[1]

| Number of Experiments | Concentration of CO in Air | Blood CO Percentage Saturation | Alveolar Air CO Parts in 10,000 | Pulse | | Symptoms |
|---|---|---|---|---|---|---|
| | | | | Normal | After Gassing | |
| | *Parts in 10,000* | *After One Hour* | *After One Hour* | | | |
| 2 | 2 | 11–12 | | 70–80 | 70–76 | none |
| 3 | 3 | 13, 10, 14 | | 72, 84, 74 | 72, 82, 74 | " |
| 11 | 4 | 22, 18, 17, 18, 14, 14, 20, 21 | 1.36, 1.33, 1.30 | 72, 74, 72, 76, 76, 70, 80 | 68, 76, 72, 80, 72, 74, 82 | " |
| 1 | 5 | | 0.9 | | | " |
| 9 | 6 | 21, 16, 16, 25, 26, 17, 16, 18, 18 | 1.30, 1.26, 1.98, 1.20, 1.00, 1.24, 1.25, 2.30 | 72, 74, 80, 72, 74, 78 | 72, 74, 82, 72, 74 | none in seven cases, slight frontal headache in two cases |
| 4 | 8 | 32, 27.8, 34, 26 | 2.3, 1.4, 2.0 | 72, 76, 74 | 88, 80, 84 | decided headache four to eight hours |
| 1 | 9 | 34 | | 76 | 80 | decided frontal headache; irritable for six hours; insomnia |
| 1 | 10 | 38 | | 78 | 90 | throbbing frontal headache; irritable; at times Cheyne-Stokes' breathing |

[1] The figures in column 3 of the above table are seen to be never more than half the equilibrium values at concentrations of six parts, or less, in 10,000 of air. For equilibrium values see Table 2.

A number of experiments on the influence of exercise were also carried out in the chamber. When the volume of breathing was thus increased the rate of absorption of carbon monoxide was proportionally increased.

TABLE 2. — EQUILIBRIUM VALUES OBTAINABLE FROM FIGURE 1

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Parts of CO in Air | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Percentage Saturation of Blood | 16.6 | 28.5 | 37.4 | 44.4 | 50.0 | 54.5 | 58.3 | 61.5 | 64.3 | 66.6 |

## III. Rate of Absorption of Carbon Monoxide and Standards of Allowable Vitiation of the Air

The essential practical results of the experiments in the 6 cubic meter chamber, and indeed of this entire investigation, are

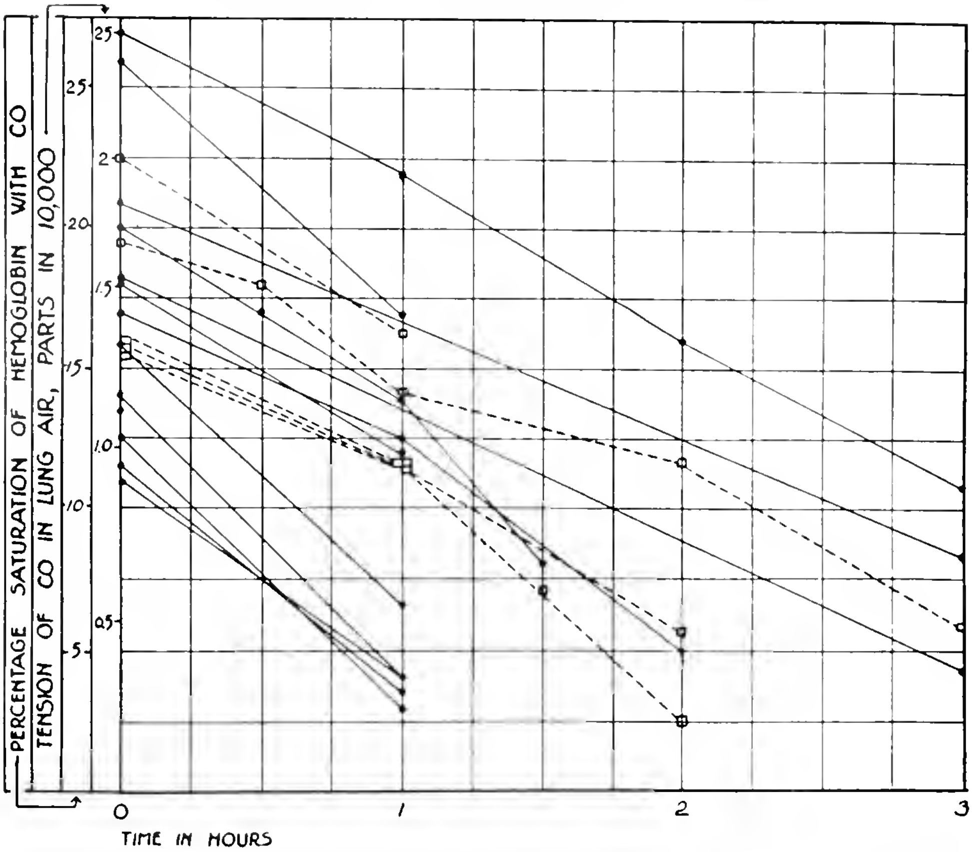


FIG. 3. — The rate of elimination of carbon monoxide after gassing. Solid lines are from analyses of blood, and dotted lines from analyses of pulmonary air.

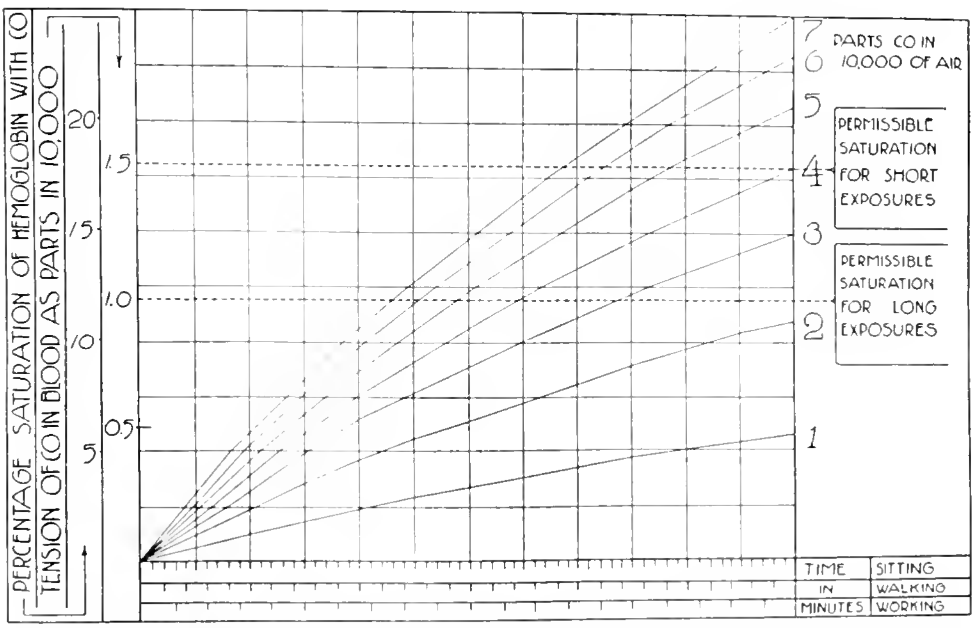


FIG. 4. — Curves showing rate of absorption of carbon monoxide by the blood in persons exposed to concentrations up to seven parts of carbon monoxide in 10,000 of air, for periods up to one hour, during rest (sitting), and for shorter periods of walking and working. For discussion see text.

summed up in Figure 4, which shows the rate at which carbon monoxide may be absorbed and the amounts at which physiological effects may occur. It is based on the data in Table 1, and is confirmed by the evidence obtained from experiments on a large number of people in the large gassing chamber — evidence which is to be presented in Section V. The curves are drawn to show the rate of absorption of carbon monoxide when air with various concentrations from one to seven parts of this gas in 10,000 is breathed. They express the absorption by the blood during one hour of one-half the amount of carbon monoxide that would be taken up after prolonged stay in each of these atmospheres.

One of the columns of figures at the left in this diagram expresses the percentage saturation attained by the blood; the other column shows the corresponding tension of carbon monoxide in the atmosphere in parts per 10,000 of air, with which the blood would be in gaseous equilibrium. In other words, the figures in column 2 indicate the amount of carbon monoxide that should be found in a pulmonary air sample, obtained by the method of rebreathing into a rubber bag, when the blood in the lungs contains these percentages of carbon monoxide. The three lines below the base line show respectively the (minimum) time required to reach these percentage saturations when the subject is at rest, when he is walking at a moderate pace and breathing a double volume of air, and when he is sufficiently active to breathe threefold, as a man at even moderate work may do. Horizontal dotted lines have been drawn at the levels of 12 and 18 per cent. blood saturation, corresponding to tensions of 1.0 and 1.5 parts per 10,000. The lower line indicates the amount of carbon monoxide which even after an exposure of several hours would not induce very disagreeable effects. The upper line expresses the level above which, in our experiments, slight discomfort and headache have sometimes resulted after an exposure of one hour.

This diagram has a very wide application. One may take off from the curves, by means of a pair of dividers, the quantities of carbon monoxide which may be absorbed by a person passing through any variety of concentrations of carbon monoxide, as may be the case in different parts of a tunnel. From the curves, one sees at a glance that if the tunnel is ventilated transversely so as to contain everywhere four parts of carbon monoxide in 10,000 — corresponding to 2,500 cubic feet of fresh air per minute per cubic foot of carbon monoxide produced by cars — a passage of three-quarters of an hour, the rate for slow trucks, would produce no appreciable discomfort. It is also evident when one plots the matter out, as has been done for the sake of illustration in Figures 5a, 5b, and 5c, that if the tunnel is ventilated longitudinally and the effluent air contains six parts of carbon monoxide, the physiological effect will be at least as good as with a uniform concentration of four parts in 10,000. In this case the ventilating fans need supply only 10,000 cubic feet of air for each 6 cubic feet of carbon monoxide thrown off by the cars in the tunnel, or 1,666 cubic feet of fresh air per minute per cubic foot of carbon monoxide. This is true if the air is forced in at one end and out at the other, and it is also true if the tunnel is ventilated in sections so that the air at some points contains only a trace of carbon monoxide and at others is contaminated progressively with from one to seven parts in 10,000 of air. This would be the case, for instance, if fresh air were driven in at the middle and ends of the tunnel and drawn out at the two intermediate points; *e. g.*, air shafts at the pier heads on each side of the Hudson River. This is illustrated in Figure 5d.

It is evident from this diagram that if at any point the concentration exceeds six

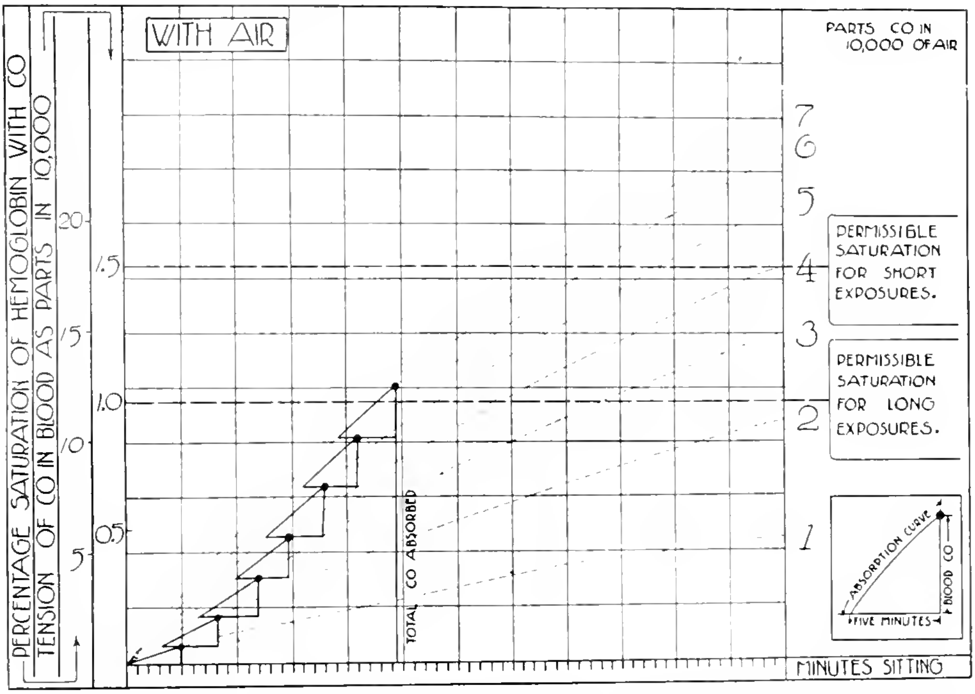


Fig. 5a. — Illustration of method for applying absorption curve data to specific conditions arising in a vehicular tunnel. Longitudinal ventilation. Subject in a sitting position travelling in direction of air current. Duration of passage through tunnel thirty-five minutes. The altitudes of the triangles express the increments of saturation of the subject's blood while passing through atmospheres increasing progressively in their carbon monoxide content. Effluent air = seven parts carbon monoxide in 10,000 of air.

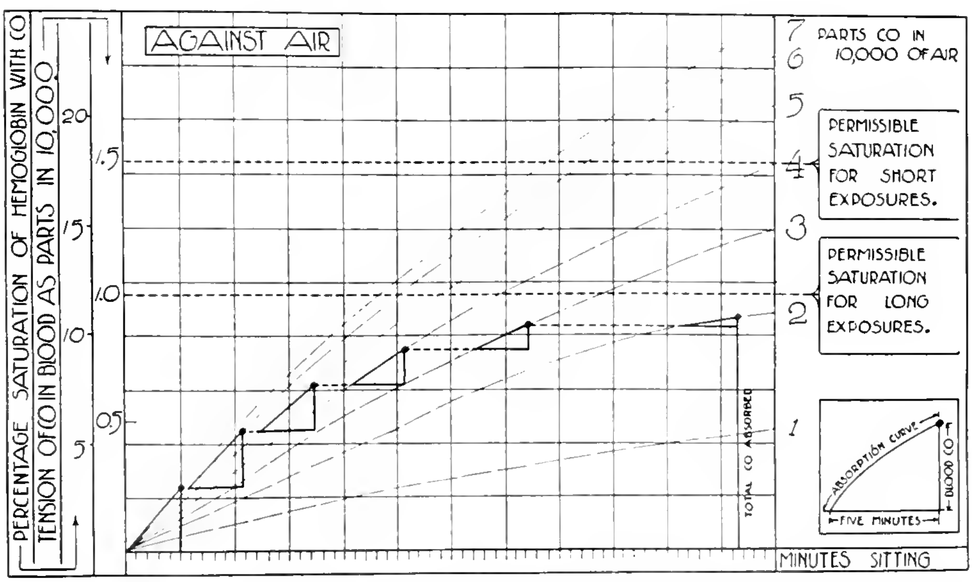


Fig. 5b. — Illustration of method for applying absorption curve data to specific conditions arising in a vehicular tunnel. Longitudinal ventilation. Subject travelling against air current. Duration of passage through tunnel thirty minutes. The altitudes of the triangles express the increments of saturation of the subject's blood while passing from effluent air containing seven parts of carbon monoxide in 10,000 through atmospheres decreasing progressively in their carbon monoxide content.

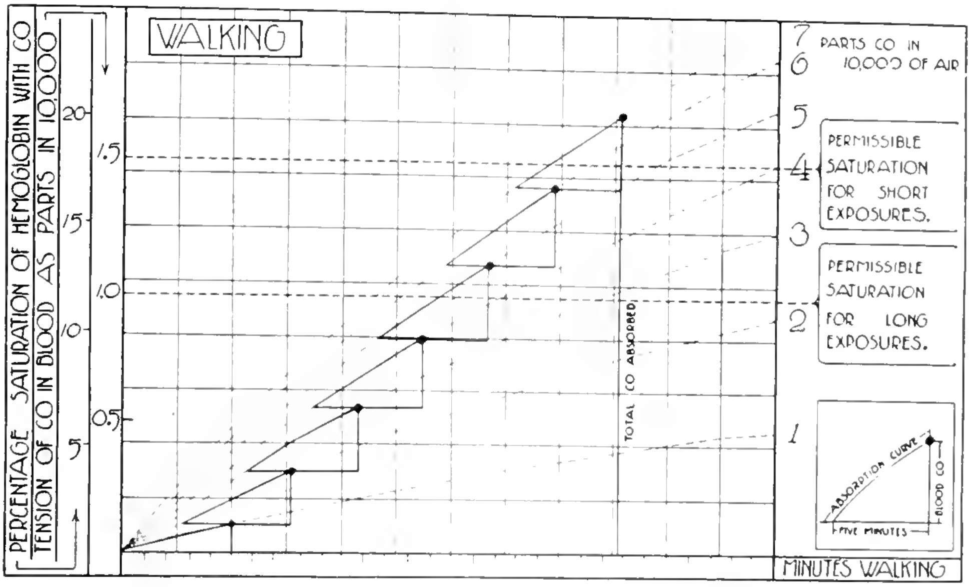


FIG. 5c. — Illustration of method for applying absorption curve data to specific conditions arising in a vehicular tunnel. Longitudinal ventilation. Subject walking in direction of air current. The altitudes of the triangles as under Figure 5a.

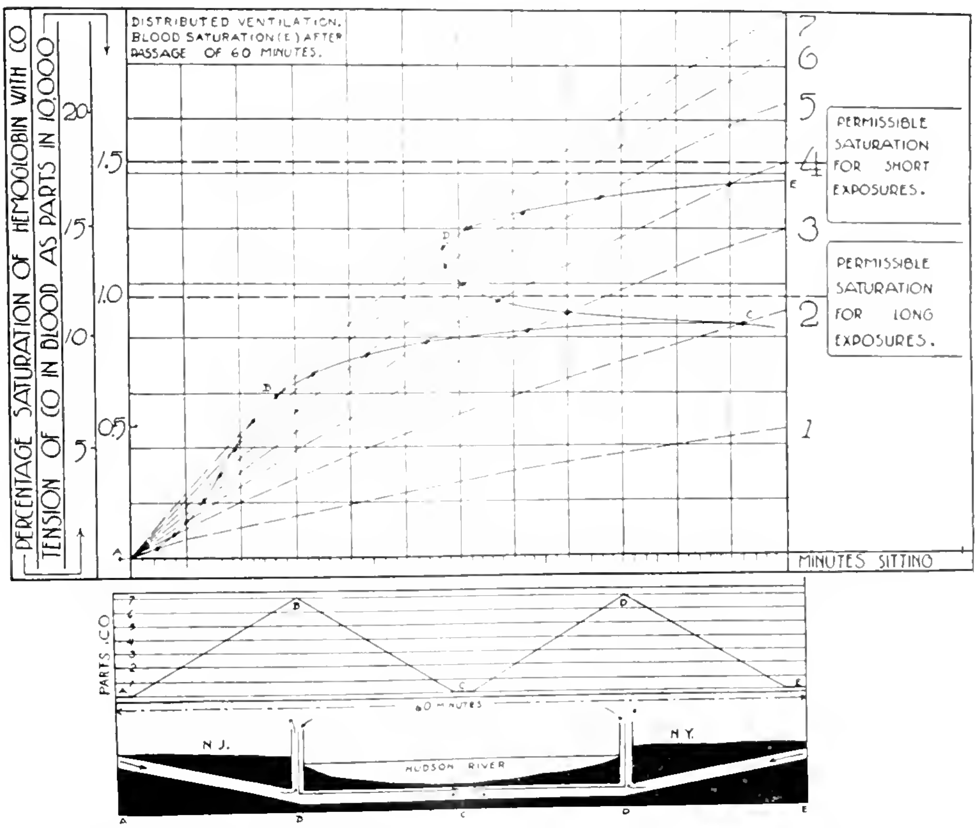


FIG. 5d. — Illustration of method for applying absorption curve data to specific conditions arising in a vehicular tunnel. Distributed ventilation. Subject in a sitting position travelling from A to E. Duration of passage through tunnel sixty minutes. The dots indicate the percentage saturation of the subject's blood at various stages of the passage. The letters A, B, C, D, and E indicate the percentage saturation of the blood when the corresponding points in the tunnel are passed.

parts of carbon monoxide in 10,000 of air, men doing hard work for even a short time will be unfavorably affected. On the other hand, the curves show that passengers in cars going through the tunnel in ten or fifteen minutes will absorb very little carbon monoxide — a factor of safety which is, we believe, sufficient to afford ample protection for children and invalids. The standard here proposed for exposures of forty-five minutes — four parts in 10,000 or its equivalent in an average of concentrations from zero up to six in 10,000 — affords, in the light of our experiments, not only complete safety but also an assurance of freedom from disagreeable effects. Risk of considerable discomfort would begin at eight to ten parts of carbon monoxide in 10,000 of air in periods of one hour during rest and for shorter periods during exertion. Actual danger would begin with concentrations not very much higher and periods not very much longer. The point should be emphasized, however, that we are dealing only with a standard of chemical purity of the air. Other features of tunnel ventilation as, for example, wind velocity, moisture, temperature, etc., are not included in the standard here defined, nor is comfort in these respects assured by it.

(*To be continued*)

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# THE INFLUENCE OF FATIGUE ON HEALTH AND LONGEVITY*

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THE final and most important test of the fatigue of a man's calling is to be found in the effect which it has on his health and longevity. Provided that he does not suffer more sickness than men in the healthiest trades, and shows no greater mortality, he has little ground for complaint even if his occupation is such as to induce a considerable degree of fatigue. Such fatigue must be within physiological limits, and so long as it does not exceed these limits and become pathological, it does him little or no harm.

Unfortunately it is a by no means easy problem to determine the influence of fatigue on sickness and mortality. We know that in some occupations, such as those of the potter, stone quarrier, and file maker, the abnormal sickness and mortality experienced are due largely to the inhalation of dust. In other occupations, such as those of lead and arsenic workers, they are due to the poisonous action of the substances handled; and in others, such as sorting wool and hides, they are due to bacterial infection. Again, we know that industrial workers who have spent all their lives in the crowded quarters of town dwellings have, as a rule, a poorer physique than those brought up in more healthy surroundings, and for this reason they may show a greater sickness and mortality, apart from any occupational effect. For instance, Dr. Arkle (1) measured the height and weight of the boys in the different grade schools at Liverpool, and he found that while boys of 14 years of age from the higher grade schools were 61.7 inches in height and weighed 94.5 pounds, those boys of the same age from the council schools, who were the sons of unemployed and casual laborers, were 6.5 inches less in height and 23.4 pounds less in weight. Boys of intermediate social status showed intermediate measurements.

## Sickness Records

It is, nevertheless, of such importance for us to determine what effect, if any, fatigue may have on sickness and longevity that even a preliminary and imperfect attempt at its estimation is instructive. Such an attempt I have recently made in one of the heaviest of our industries, the iron and steel trade (2). Under the National Health Insurance Act the sickness of all industrial workers in Great Britain has been systematically recorded since 1913, and much of this material is in a form suitable for statistical treatment. Working in conjunction with Mr. E. A. Rusher, F.I.A., an actuary of long experience, I tabulated the sickness and mortality records of about 24,000 iron and steel workers for a six-year period, 1913–1918, and Mr. Rusher and his staff have worked up this material according to approved actuarial methods. My object was to separate the men into clearly defined occupational groups, the character of whose work was well known to me as the result of close observation. Among the steel workers, five clearly defined groups of skilled men were thereby obtained, while a certain number of other skilled men, whose numbers were too small to admit of their consideration as separate groups, had to be thrown into the general group of unskilled laborers and others.

The number of days of sickness per year suffered by these occupational groups are

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recorded in Table 1. On an average they came to 6.5 working days per year, and in addition there was a small amount of time (estimated as 0.6 day) which is not compensated for under the Insurance Act, and which is not included in the recorded figures. The group of steel melters (on open hearth furnaces), teemers, and pitmen head the list, and show 23 per cent. more sickness than the average of all the workers combined. Next come the puddlers of wrought iron, with a 20 per cent. excess; then, the tinplate mill-men with a 12 per cent. excess; and then the rolling-mill men, with an 8 per cent. excess. All of these men work under trying conditions of high temperature, especially the first three groups mentioned, while the engine men and the general workers, who for the most part work under ordinary conditions of temperature, were found to show 8 or 9 per cent. *less* sickness than the average. At first sight, therefore, we seem to have a clear relationship between cause and effect, but an analysis of the time lost under the various categories of sickness does not altogether bear out the simplicity of the relationship. Sickness was classified under (*a*) rheumatism (acute and chronic), lumbago, myalgia, and neuritis; (*b*) pneumonia, bronchitis, influenza, pleurisy, catarrh, and sore throat (but not phthisis); (*c*) injuries incurred when following employment; (*d*) sickness due to other causes, and injuries incurred apart from employment.

It will be seen from Table 1 that the excess of sickness experienced by the puddlers was due entirely to rheumatism and respiratory diseases, probably resulting from the habits of the men. The puddlers generally work in couples, and they put in alternate periods of about twenty minutes of very strenuous work at puddling their molten iron, and of comparatively light work. They perspire freely during their heavy work, and as they sit about a good deal during their intermediate periods, usually in a draft, they render themselves very liable to chills. The tinplate mill-men, whose work is on the whole as hot and heavy as that of the puddlers, show no excess of rheumatism and respiratory disease. This is due, I believe, to the fact that these men work continuously throughout their six or eight-hour shift. I kept groups of them under observation for several days, and I found that they seldom took rest pauses of more than four minutes'

TABLE 1.—DAYS OF SICKNESS PER YEAR EXPERIENCED BY STEEL WORKERS AGED 16 TO 70 (1913–1918)

| Occupation | Approximate Number of Workers | Days of Sickness per Year Due to | | | | | Percentage Variation from Average of All Workers Combined | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rheumatism | Respiratory Diseases | Injuries | Other Causes | All Causes | Rheumatism | Respiratory Diseases | Injuries | Other Causes | All Causes |
| Steel melters, teemers, and pitmen | 1,740 | 1.3 | 2.2 | 1.2 | 3.3 | 8.0 | +44 | +10 | +71 | +14 | +23 |
| Puddlers | 970 | 1.6 | 2.7 | 0.7 | 2.8 | 7.8 | +78 | +35 | . . | −3 | +20 |
| Tinplate mill men | 2,090 | 0.9 | 2.1 | 0.8 | 3.5 | 7.3 | | +5 | +14 | +21 | +12 |
| Rolling-mill men, soaker men, hot-bank men | 2,470 | 0.9 | 2.0 | 0.9 | 3.2 | 7.0 | | . . | +29 | +10 | +8 |
| Engine men, crane men, locomotive men | 1,660 | 0.6 | 2.2 | 0.4 | 2.8 | 6.0 | −33 | +10 | −43 | −3 | −8 |
| All other workers (largely laborers) | 11,740 | 0.8 | 1.9 | 0.5 | 2.7 | 5.9 | −11 | −5 | −29 | −7 | −9 |
| All workers combined | 20,670 | 0.9 | 2.0 | 0.7 | 2.9 | 6.5 | . . | . . | . . | . . | . . |

duration, and never rested more than nine minutes (3).

It will be seen that most of the extra sickness suffered by the tinplate mill-men is due to "other causes," and it is possible that this is the result of fatigue, which lowers their resistance to disease in general. The steel melters show an excess of sickness from rheumatism and from respiratory diseases, as well as from "other causes," and this general excess definitely suggests a fatigue effect. The work done by the steel melters when fettling (*i. e.*, mending) the bottom of their furnaces is more strenuous and exhausting than any other kind of industrial labor with which I am acquainted. It obliges the men to approach to within a few feet of the partly open doors of the white hot furnace, and to push away the pools of molten steel with a kind of rake or "rabble." Subsequently the depressions in the bottom have to be filled up with dolomite or other material. This heavy work is very intermittent, and it lasts, on an average, only an hour or less per shift. After doing it the men not infrequently change their wet shirts. Also, unlike the puddlers, they are often provided with shelters into which they can retire, so there is some reason for thinking that their excess of rheumatism and respiratory disease may be due not only to chills arising from their work, but to lowered bodily resistance, the result of fatigue.

On separating the workers according to age groups, it was found that the older men, of 55 to 69 years of age, lost 6.3 times more time from rheumatism than the young men of 16 to 29. This great increase was specially observed in the men working at high temperatures, and the older steel melters and pitmen lost no less than 7.7 times more time than the young ones. On the other hand, the older engine men and "other workers" lost only 3 to 5 times more time from rheumatism than the young men in the same occupations. It is true that the total number of days lost by the older men in no case exceeded 3.1 days per year, but it is probable that the efficiency of the men would be lowered for weeks every year, rather than for days, in consequence of rheumatic pains.

TABLE 2. — DAYS OF SICKNESS PER YEAR AMONG BLAST FURNACE MEN BY AGE GROUPS

| Occupation | Days of Sickness per Year by Age Groups Due to | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Rheumatism | | | Respiratory Diseases | | | All Causes Combined | | |
| | 16–33 | 34–48 | 49–69 | 16–33 | 34–48 | 49–69 | 16–33 | 34–48 | 49–69 |
| Barrow fillers. . . . . . . . . . . | 1.0 | 1.1 | 3.8 | 2.7 | 2.6 | 4.2 | 8.5 | 7.5 | 12.7 |
| Laborers and helpers. . . . . . | 1.3 | 1.0 | 4.0 | 2.3 | 2.6 | 4.9 | 6.6 | 7.8 | 15.9 |
| Other workers. . . . . . . . . . . | 0.4 | 1.3 | 2.7 | 2.3 | 2.0 | 3.6 | 4.4 | 7.9 | 13.1 |
| All workers combined | 1.0 | 1.1 | 3.4 | 2.4 | 2.4 | 4.1 | 6.8 | 7.7 | 13.6 |

Data relating to blast furnace men are recorded in Table 2. They were obtained from a different "Approved Society" (working under the Insurance Act) from that of the steel workers, and they are classified in different age groups. They relate to 1,002 blast furnace men, and they show that men of 16 to 48 years of age experienced one to two days' more sickness per year than the steel workers, while men of 49 to 69 experienced about four days' more sickness. The excess of sickness was due partly to respiratory diseases, but especially to rheumatism. Thus, the men of 49 to 69 lost 3.4 days from this cause, while steel workers of the same age lost only 1.7 days, or half as much. It seems highly probable that this excess of sickness from rheumatism and respiratory disease

was due to exposure to the weather, for it was specially marked in the barrow fillers and the laborers, who are almost always working in the open without any kind of protection from the elements. It was less evident in the other and more protected group of men, which includes the keepers, molders, gas men, cleaners, engine men, and crane men.

## Mortality Records

It is extremely difficult to obtain adequate mortality records, for though very extensive records are collected and published at ten-year intervals by the Registrar General, they relate to such large occupational groups as to be of little value for our special purpose. For instance, the iron and steel workers whose sickness has just been discussed are placed with iron founders and with the makers of iron goods (such as stoves and bedsteads) in one comprehensive group, and no separation into individual occupations is possible. Accordingly, I had to fall back upon the mortality records of the steel workers already referred to, but data relating to 3,540 blast furnace men were obtained.

The total deaths recorded among the 20,670 steel workers in the six-year period under observation came to 1,023, and those among the blast furnace men, to 337. The mortality rates have been compared with those of all males (occupied and retired) in England and Wales, in the years 1910–1912, and the "expected" numbers of deaths recorded in Table 3 are calculated from the Registrar General's data (4). From the final columns of the table it will be seen that while 1,018 deaths were "expected" between the ages of 25 and 65, only 964 deaths were observed. In other words, the steel workers showed 5 per cent. less mortality than the general male population. This must not be taken to indicate that steel manufacture is a healthy occupation, for the group of "all males, occupied and retired," includes many weaklings who are unfit for any trade, or only fit for light work, while most steel workers have necessarily to be healthy men of good physique. Men in the healthiest occupations have a much lower mortality. The comparative mortality figure, which gives a death rate in which due allowance has been made for age distribution between the ages of 25 and 65, is 753 for the steel

TABLE 3.—TOTAL DEATHS AMONG STEEL WORKERS (1913–1918) COMPARED WITH THOSE AMONG ALL OCCUPIED AND RETIRED MALES (1910–1912) BETWEEN THE AGES OF 25 AND 65

| Occupation | Respiratory Diseases | | | Tuberculosis | | | All Causes Combined | | |
|---|---|---|---|---|---|---|---|---|---|
| | Actual Number | Number Expected | Percentage Variation from Number Expected | Actual Number | Number Expected | Percentage Variation from Number Expected | Actual Number | Number Expected | Percentage Variation from Number Expected |
| Steel melters, teemers and pitmen | 35 | 16.0 | +119 | 15 | 20.1 | −25 | 125 | 104.5 | +20 |
| Puddlers | 30 | 11.6 | +159 | 7 | 11.2 | −38 | 66 | 73.1 | −10 |
| Tinplate mill men | 22 | 14.8 | +49 | 7 | 21.0 | −67 | 69 | 99.3 | −31 |
| Rolling-mill men, soaker men, hot-bank men | 36 | 16.7 | +116 | 11 | 24.0 | −54 | 114 | 112.9 | +1 |
| Engine men, crane men, locomotive men | 22 | 13.0 | +69 | 10 | 17.3 | −42 | 77 | 86.5 | −11 |
| All other workers | 165 | 81.2 | +103 | 55 | 110.3 | −50 | 513 | 541.6 | −5 |
| All workers combined | 310 | 153.3 | +102 | 105 | 203.7 | −48 | 964 | 1,018 | −5 |

workers, as compared with 790 for all males, occupied and retired. In the healthiest occupations, such as gardening, the figure is 457. That of farmers and graziers is 495, while at the other end of the scale come potters with a mortality figure of 1,196, and stone getters and masons with one of 1,427.

Again, there can be no doubt that all the mortality figures recorded in Table 3 underestimate the death rate. In many trades, especially in the heavy occupations, there is a continual weeding out of some of the less vigorous men, who drift into the ranks of the casual and unemployed workers, and the removal of these weaker men lowers the death rate of those remaining in the trade. The records showed that about 1 per cent. per year of the skilled workers aged 54 or less disappeared, while 3 per cent. of the older men suffered the same fate. Among the "other workers" class the proportions were about twice as great. It follows, therefore, that it is impossible to gauge the effect of industrial work upon mortality with any approach to accuracy unless the history of all the workers can be traced after they have dropped out of their trade. Nevertheless, the data recorded are roughly comparable among themselves, and they show clearly that some occupations are more harmful than others. We see that the steel melters and pitmen head the list, and have a mortality 20 per cent. greater than that of all males, or 26 per cent. greater than the average of the whole group of steel workers investigated. This figure corresponds closely with the sickness figure, which was 23 per cent. above the average, and it suggests that the fatigue of the steel melters' work is responsible not only for more sickness, but for a loss of several years in the average expectation of life. It will be seen that the steel melters experienced more than twice the usual mortality from respiratory diseases, and, in fact, every one of the groups of men in the various occupations experienced a somewhat similar excess from this cause. From tuberculosis (almost always phthisis) the steel melters experienced about three-fourths the usual mortality, while the other groups of men experienced only one-third to two-thirds as much. This result was probably due in part to the fact that almost all the men were working in the open air or in sheds. Such exposure tends to reduce phthisis, though it may increase the risk of respiratory diseases in general. There can be no doubt, however, that many tuberculous workers drop out altogether from the strenuous work required in the iron and steel trade before death carries them off.

TABLE 4. — MORTALITY OF BLAST FURNACE MEN (1913-1918)

| Age Group | Percentage of Deaths per Year among | |
|---|---|---|
| | Blast Furnace Men | All Males |
| 16–33 | 0.8 | 0.4 |
| 34–48 | 1.3 | 0.9 |
| 49–58 | 2.7 | 2.0 |
| 59–69 | 5.8 | 4.4 |

The puddlers, who showed almost as much sickness as the steel melters, had a slightly lower mortality than the average, but their mortality from respiratory disease resembled their sickness from the same cause in showing a maximal value. The engine and crane men showed a smaller excess of deaths from respiratory disease than any other group except the tinplate mill men, presumably because they were not so much exposed to the weather or to high temperatures. The comparative immunity of the tinplate mill men from fatal respiratory disease is presumably due to their custom of working continuously during their shift, without any long rest pauses, and at the end of the shift going back promptly to their homes, which are usually situated in the neighborhood of the works.

The blast furnace men showed a considerably higher mortality even than the steel melters, as can be seen from Table 4, the data in which relate to the whole body of blast furnace men. These figures suggest that moderately heavy work, if carried out under ordinary temperature conditions but with exposure to all kinds of weather, is more fatal than very heavy work, carried out at high temperatures but with shelter from the elements.

## Conclusion

The data as a whole appear to indicate that in men of good physique the fatigue of heavy work has, as a rule, but little direct effect on sickness and longevity. It is probable that the excessively exhausting work of the steel melters forms an exception to this dictum, but it seems highly probable that the heavy work of the iron puddlers, of the tinplate mill men, and of the rolling-mill men has no injurious effect on health except indirectly, when it induces the men to sit about in damp clothes. The men may be working nearly to the limit of their strength, but the mere fact that they have to continue on the same class of work week after week and year after year must deter them from overstraining themselves, unless they do it unwittingly. At the time these observations were made, many of the steel melters, rolling-mill men and blast furnace men were on a twelve-hour day, while the puddlers were usually on an eleven-hour day. Since the spring of 1919 they have all gone on to an eight-hour day, so their labor is considerably lightened.

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# SYPHILIS AND INDUSTRY*

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THE objective of an occasional or periodic physical examination is to protect against future disease and accident — in other words, to extend life and promote efficiency. From the standpoint of the state, this objective may be more specifically described as the protection of the public health, by the recognition of communicable disease at the time of the examination, and the safeguarding of the future against dependency caused by depreciation of health or through injury which may result in permanent or transient, partial or total, mental or physical disability, and which may possibly call for the expenditure of public moneys for material relief.

For the individual, the periodic physical examination furnishes a means of protection against communicable disease in his fellow citizen, as well as a means by which defects that may contribute to his own health depreciation or liability to injury may be recognized. The employer's objective, on the other hand, is the protection of the community in which his industry is located, of the worker as an economic unit, and of the material and equipment of his plant, through the early recognition of those contributory factors that tend to cause health depreciation or accident occurrence.

Any single factor that is of considerable prevalence, easy to recognize, and relatively simple to eliminate, and that is, at the same time, a known detriment to community welfare, individual health, and industrial efficiency, deserves greater thought than has hitherto been given to *syphilis*. No medical argument is needed to prove that syphilis is communicable and that, in its active stage with open lesions, it is a menace to people working in close contact, with common tools or utensils. Nor is proof required that the late disabling manifestations of syphilis of the nervous system cause accidents and contribute to damage of property. It is evident, however, that attention still has to be called to cardiac, nephritic, digestive, and other "diseases" as possible symptomatic indications of an underlying syphilis, often overlooked in the course of the usual routine examination.

Any short cut, if not practicable, is of no advantage, and a routine Wassermann test as a short cut undeniably has its impracticalities. It is relatively expensive. It hurts a little to have some one "stick a needle" into one's arm. It prolongs the examination. Its mere mention still brings forth much of the old stigma of "venereal" disease. Moreover, it requires careful interpretation of reports and often frequent repetitions. But none of these nor any other of its impracticalities is insuperable, so why not go around the obstacle instead of standing by and saying it cannot be done without a short cut through. As a matter of fact, the shortest way to the objective of recognizing syphilis is to be found in the longer procedure of the ordinary physical examination. Greater specializing in parts of the routine examination for certain occupations makes for easier recognition of special defects. Therefore, the more value there is attached to examinations designed to detect such defects, the more important becomes the recognition of syphilis.

The most primitive routine examination for employment calls for an "inspection" of the applicant, which necessitates, at least, looking at the individual. If the inspector looks while the person is walking, his gait may suggest locomotor ataxia. His eyes, also, by such signs as irregular,

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unequal pupils, etc., may be of significance. Moreover, while conversing with the applicant, defective hearing may be detected, as may also such voice defects as monotony, harshness, or low pitch. Cervical glands may be palpated or an epitrochlear gland felt without actually doing more than a simple inspection requires. These danger signals, noticed during a very rapid inspection, call for further examination for the detection of additional signs that may lead to a diagnosis of "suspected" syphilis.

The average routine examination which calls for a simple history of past illness, an inspection of the head and neck, listening to the heart and lungs, and palpation of the inguinal region for hernia, markedly enlarges the opportunity for finding signs and symptoms of syphilis. Not only the obvious signals of abnormal gait, irregular and unequal pupils, defective hearing and voice abnormality may be detected, but also, with practically no consumption of time, the observant examiner may note the reaction of the pupils to light and accommodation; the presence of interstitial glossitis, leukoplakia, and Hutchinson's teeth; glandular enlargements (particularly epitrochlear nodes); scars (circular, pigmented, depressed, attached to underlying bone); and cardiac conditions (especially aortic valve disease). The finding of any *one* of these signs calls for further examination; the presence of *two* indicates the necessity for a Wassermann test for confirmation of suspected syphilis.

Where nursing and clerical help are available for such work as the taking of the history, temperature, height, weight, eye tests, and hearing and voice tests, a complete physical examination can be made by the medical examiner in ten minutes or less if his routine procedure is thoroughly systematized. With the nurse making the eye observations for pupillary irregularity, inequality, and reaction to light and accommodation, the examiner's observation of the applicant's head, nose, and throat may detect interstitial glossitis, Hutchinson's teeth, leukoplakia, ulcers or scars of the nasal septum, cervical adenitis, suggestive scars on the forehead, angles of the mouth, and alae of the nose, etc. While the examination of the heart and lungs is being made, the examiner may exercise his powers of observation to take cognizance of the skin of the chest, back, and arms for rash and scars not evidently due to injury or acne, at the same time that his ears tell him whether or not any aortic valve condition exists. Likewise, his examination of the abdomen enables him to "double up" and look for the same signs while palpating. A hard, palpable liver is one more signal. In examining for hernia, the telltale syphilitic inguinal glands may be found, as well as the testicle that has become harder and larger than usual. There are, too, other possibilities in the examination of the genitalia. Similar skin inspection of the lower extremity takes no time, and but a moment is required for an investigation of the knee jerks.

In making these observations, only a moment or two is added to the examination time, and, as syphilis is an important consideration for industry, it will be suspected in a high percentage of cases. In most cases showing more than one of the above-mentioned signs, the suspicion will be confirmed by a further examination, including the Wassermann test. If the desideratum is a simple examination consuming the least possible amount of time, it is possible to set down a series of syphilis signs that will guide the average examiner in culling out those individuals who require more detailed consideration and from whom it is desirable to procure blood for a Wassermann test.*

* When, as a result of any type or form of physical examination, evidence suggestive of lues of the nervous system is ascertained, it should be a routine procedure to do a lumbar puncture with a serologic examination of the cerebrospinal fluid.

In summary, it may be said that if any one, or any combination, of the following easily observable signals can be found, further examination for the detection of syphilis is necessary: ataxic gait; mental slowness; defective hearing; voice defects; pupils, irregular, unequal, or reacting abnormally to light and accommodation; enlargement of the lymph glands, especially of the epitrochlear nodes; interstitial glossitis; leukoplakia; Hutchinson's teeth; scars not obviously due to injury; cardiac conditions; and altered reflexes, especially knee jerk.

The industrial physician is probably justified in taking the view that a routine Wassermann is not possible at the present time, but he is not justified in overlooking the easily observable signs and symptoms that will promote the health of the employee and protect the employer from responsibility for preventable accidents.

# TRINITROTOLUENE AS AN INDUSTRIAL POISON*

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IN the summer of 1918, the National Research Council undertook an inquiry into the occurrence of industrial poisoning in munition works, and as one feature of this study they assigned to six typical T.N.T. plants medical students who had been trained in laboratory methods and in making clinical observations, in order to have them collect important data on the spot. The work was carried on in co-operation with the U. S. Department of Labor, the Public Health Service, and the War Department. The plants which were selected manufactured trinitrotoluene, or purified the crude, or loaded shell with pure trinitrotoluene or with the mixture of ammonium nitrate and T.N.T., known as amatol. Six students spent from one to two months at the plants assigned them, making observations on selected groups of the men and women employed there. Although the results of their studies, coming as they did in the fall of 1918, could not be put to practical use because of the closing down of these plants when the armistice was signed, it seems worth while to publish them because compounds very similar to trinitrotoluene are coming into increasing use in American industry. It is not likely that any other derivative of the benzene ring will ever be used on so gigantic a scale as was T.N.T. during the war, and all the information that was gathered during that great human experiment should be made known because of its probable application to the less well known compounds which are used in the manufacture of dyes and drugs.

At the time this study was made we had been able to learn a good deal about T.N.T. poisoning and its prevention from the British, but several points were still a matter of controversy, and it was to these that we devoted special attention. A study of industrial poisoning in the manufacture of explosives, which had been published by the Bureau of Labor Statistics in 1917, had shown that in American plants, as in the British, all varieties of T.N.T. poisoning were to be found from the so-called "minor T.N.T. sickness" to fatal toxic jaundice (1). The first death from the latter in England was reported in February, 1915, and the first death in this country came to light just about a year later (2).

T.N.T. is made by the nitration of toluene either by a continuous or by an interrupted process. There is little danger of exposure to poison for the workmen engaged in nitration, but the subsequent separation and purification of crude T.N.T. was, in this country, attended with very decided risk of poisoning — a risk actually as great as in shell loading. This was apparently not true in England, for there the great majority of cases of poisoning developed in the "filling," or, as we call them, loading plants. Thus, there were in Great Britain, in 1916 and 1917, 370 cases of toxic jaundice with ninety-six deaths, but only sixteen of the cases and two of the deaths were reported from the manufacturing plants (3). The nitration and purification of T.N.T., so prolific a source of T.N.T. poisoning in American munition plants, was evidently carried on under far greater precautions in England than here.

Commercial T.N.T. is mainly composed of the symmetrical isomer, a hard, crystalline powder, pinkish yellow if fairly pure, melting and subliming at 82° C. The im-

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purities present in crude T.N.T. and to a certain extent in the purified T.N.T. consist in insignificant quantities of the two other isomers and a varying percentage of mononitrotoluene and dinitrotoluene, and also nitrated methanes. Early in the war the question arose whether T.N.T. poisoning was caused by the pure substance or by one of the above impurities, and the suggestion was made that cyanosis and minor T.N.T. sickness might be caused by T.N.T. but that some other substances might be responsible for toxic jaundice and aplastic anemia. The British (4) came to the conclusion that pure T.N.T. was capable of setting up all these varieties of poisoning, while the Germans (5) concluded from their experience that toxic jaundice appeared only when impure T.N.T. was handled, and that tetranitromethane was probably the compound responsible for it. With this, the French (6) experience harmonized.

All the early efforts in Great Britain to prevent T.N.T. poisoning were directed against contamination of the air by fumes and vapors. Moore's experiments (4) threw doubt on this mode of entrance for T.N.T. and showed the importance of skin absorption. Indeed, he went so far as to declare that there was no need of carrying off fumes from melting pots, and that dust caused poisoning only because it fell on the skin and on work benches and objects which the workpeople had to handle. The other British authorities took a more conservative stand on this question, and the Home Office experts insisted on the prevention of fumes (3), but the overwhelming importance of the skin as a portal of entry for T.N.T. was generally admitted.

A great help in solving the questions of absorption, elimination, the relative danger of different kinds of work and of different mixtures containing T.N.T. was found in the so-called Webster test for the urine (4). This is a method of detecting in the urine a reduction product of T.N.T., dinitrohydroxylamino-toluene, and as it is a color reaction varying from a pale pink to a deep purplish pink according to the quantity of this reduction product present, there was no difficulty in standardizing it and thus bringing the observations of the different students into harmony.

The students assigned to the nitrating, purifying, and shell-loading plants were asked to make observations on problems of a thoroughly practical character, for although the United States had been in the war for more than a year the government had not yet formulated a sanitary code for the control of the explosives industry, and all attempts to do so met with opposition — an opposition which, it was felt, might be overcome if the managers of these plants were confronted with a body of facts gathered from American sources. The following questions were assigned to the students:

1. Can T.N.T. poisoning occur as the result of breathing fumes or dust, without skin contact?

2. Is susceptibility to poisoning influenced by race, sex, age, climate?

3. How long an exposure is necessary before T.N.T. can be detected in the body?

4. How long does it take to get rid of the T.N.T. that has been absorbed?

5. Which is more poisonous, crude T.N.T. or the pure; unmixed T.N.T. or amatol?

6. What are the earliest symptoms of T.N.T. poisoning?

7. What is the practical value of the Webster reaction?

8. Is there any change in blood or urine which can be depended on to give warning of danger?

Of the 402 workers who were examined in the six plants, only thirty-six were women. The conditions under which these people worked varied so much that some description of the plants will be necessary to account for the different results ob-

tained by the students. Plants 1 and 2 were assigned to Miss Alice Hall, a third year student at Rush Medical College. They were situated not far apart in northeastern New Jersey, in hot, shadeless country where the August heat of the summer of 1918 was at times excessively trying. Methods of work differed somewhat in the two plants, but they were both unusually neglected and unclean. The floors and benches, especially in one of the pouring rooms, were covered with drippings of molten T.N.T., the rooms were crowded and poorly ventilated, and both fumes and dust were allowed to escape into the air. The washing facilities were very inadequate, and, as they were not conveniently situated and time was not allowed for the men to bathe, they were not much used. Even the men who were cleanly in their habits found it very hard to keep clean, and naturally the labor turnover was very great and the force was for the most part recruited from the lowest class of labor. No instructions were given the workmen, and in neither plant did the physicians have anything to do with shop sanitation. Their duties were confined to holding office hours at stated times when men who fell sick and had confidence in the plant doctor could seek him out and ask for care. They did nothing to prevent sickness and not very much in the way of treatment, for if they thought a man likely to develop a serious case of poisoning, they promptly discharged him, for the protection of the company.

Miss Hall saw more cases of severe poisoning than did any of the other students, but she was hampered in her study of these cases because there was no hospital where they could be closely observed and because her notes of a case were usually brought to an abrupt end by the man's discharge or by his quitting of his own accord. She was never able to follow a case over a long period as could some of the other students.

In Plant 3, also in northeastern New Jersey, shell was loaded with amatol 50–50 and 80–20.* Miss Jewel Emery, laboratory technician from the Michael Reese Hospital, Chicago, spent a month there. It was a U. S. ordnance plant, new, clean, well constructed, and carefully managed, except that medical supervision was not thorough enough and there were no hospital facilities. The employees were of a better class than in Miss Hall's plants, but there was an unusually large proportion of young men among them.

Plant 4, which was in Virginia, was assigned to Richard TeLinde, a third year student in the University of Wisconsin Medical School. Shell was loaded in this plant with the two varieties of amatol. The plant was partly new, clean, large and well ventilated; partly old, rather crowded and dirty, and in some places very dusty. The men employed were negroes and southern whites, many of them from the North Carolina mountains, of poor physique and anemic. The medical care given at this plant was by far the best that we found anywhere, and included inspection of the men and women in their workrooms, the shifting of all suspicious cases from T.N.T. work to safe work, and the treatment of sick men in a well-equipped hospital. Mr. TeLinde was able to make observations on men for long periods and to follow a case of sickness to recovery, but he never saw as serious cases as did Miss Hall.

Plant 5 was in northern Wisconsin near Lake Superior. Here D.N.T. and T.N.T. were made, and purified and packed. The employees were decidedly superior to those employed in the other plants. Conditions were very good, there were ample facilities for washing, and medical care was good but insufficient, one physician with a part-time assistant not only having about 3,000 men under his care but also being responsible for the examination of all applicants

* Ammonium nitrate 50 per cent., T.N.T. 50 per cent., and ammonium nitrate 80 per cent., T.N.T. 20 per cent.

for employment. It was therefore impossible for the student at this plant to make as careful observations as were possible in Plant 4, especially as there was no hospital on the grounds. Norton Eversoll, a third year student in the University of Wisconsin Medical School, was assigned to this plant.

The work that was done in Plant 6 has already been described by Tracy Jackson Putnam and William Herman (7), the two Harvard Medical School students who spent a month there. Plant 6 was a purification, "finishing" plant, situated in the mountains of Pennsylvania. It was a fairly clean place except in two departments, and even those were not excessively bad, but the men were not given proper working clothes nor were the wash rooms adequate or comfortable. The medical care of sick men who applied for treatment was good, but there was no preventive work and no effort to discover cases of poisoning. Both negroes and whites were employed.

## Mode of Entrance of T.N.T.

It was impossible for us to obtain as clear evidence on the mode of entrance of T.N.T. as was gained by the British in their carefully regulated factories. No American plant was clean enough to make skin absorption even a rarity. Everybody employed in every department came in contact with T.N.T. dust and had his skin more or less covered with it. We could only make an effort to determine whether fumes and contact caused more poisoning than contact alone, and whether inhaling dust increased the incidence of poisoning. The reports from certain plants seemed to show that fumes and T.N.T.-laden steam decidedly increased the risk of poisoning. For instance, the graining, pelleting, and washing rooms of the purification plants, where fumes mixed with steam were more or less heavy, gave rise to many cases of sickness, especially in cold weather, when the doors were closed, and also in heavy, hot, summer weather.

According to Putnam and Herman, the procedure most dreaded in their purifying plant was cleaning out the bottoms of the great tanks in which crude T.N.T. had been boiled. The heat, moisture, and fumes in the tanks were overpowering and many men refused to enter them. Another piece of work which, according to the workmen, often caused deep cyanosis and fainting, was cleaning a room by volatilizing and melting with live steam the T.N.T. which had been spilled and splashed about. As for dust, it was found that pure, dry T.N.T. dust did not cause poisoning unless present in such quantities as to cover the skin of the workers. Pressing pure T.N.T. into detonator charges or demolition blocks seemed to be harmless work. On the other hand, small quantities of amatol (T.N.T.-ammonium nitrate) dust proved distinctly poisonous, although it contained only a small proportion of T.N.T.

A closer study of these findings led us to indorse the British view of the overwhelming importance of the skin as a portal of entry for T.N.T. because the same conditions that make respiratory absorption possible also increase skin absorption, and the greater toxicity of amatol as compared with pure T.N.T. depends on its greater absorbability. The instances given above of poisoning from steam and fumes can also be explained as due to the facilitation of skin absorption by heat and moisture. Grainers, pelleters and tank cleaners in purification works have their hands and forearms more deeply stained with T.N.T., even after a single day's work, than do men pressing charges at the end of several weeks' work. The dust of pure T.N.T. is not very readily absorbed by the skin. If one looks at the arms and hands of a man who is sifting or pressing dry unmixed T.N.T., one can see the powder covering the hairs of the skin, but unless the day is

hot enough to cause much perspiration this powder is dry and hardly stains the skin at all. In the graining and pelleting rooms not only is the T.N.T. which the men handle warm and wet, but the steam and fumes keep the skin moist all the time.

The same contrast was found by TeLinde between a drilling department where there was much amatol dust and a department in which pure T.N.T. was sifted. There was a great deal of sickness in the former department, and almost none in the latter. The amatol dust contained 50 per cent. of ammonium nitrate, and this, because of its hygroscopic nature, kept the skin of the workers moist. Tiny droplets of water could always be seen on the skin and hairs of the men's hands and arms, and on all the metallic surfaces in the room. Our experience in this country agreed with that of the British, who found that there was more sickness in connection with 80–20 amatol, containing only 20 per cent. T.N.T., than with pure T.N.T. We also found, as the British had, that oily substances favored the absorption of T.N.T. Two of the earliest American cases of toxic jaundice, one of them fatal, were in women exposed to very small quantities of amatol, but whose hands were smeared all the time with paraffin.

Although our observations showed that the skin is the chief channel of absorption for T.N.T., and that the prevention of poisoning means prevention of contact, still we were not convinced that T.N.T. fumes from grainers, washing tanks and melting kettles were harmless. Some of the students' case histories seemed to point quite clearly to fume poisoning, as, for instance, that of a new employee who was set to work on a fairly cool day in June stirring a kettle of molten T.N.T. which was poorly hooded. He became dizzy and faint, and went to the plant doctor who found him cyanosed, with weak and rapid pulse. He was suspended from work that day (Monday) but on the following Friday he was still feeling ill and his urine was still dark in color. Several students reported cases of men who, having once suffered from T.N.T. sickness, could go back to work with the substance, but if they were exposed to the fumes would suffer a return of the headache, dizziness, breathlessness and weakness with which they were familiar from their former experience. A very interesting report on this point was sent by Alice Hall. On two occasions she remained for two or three hours in the pouring room where the air was heavy with T.N.T. fumes, being careful not to touch anything during that time. After both these exposures she was able to get a positive Webster reaction. The superintendent of a department in one of the Navy arsenals, where depth charges and mines were loaded, told me that poisoning among his men was practically 100 per cent., not one of them having been able to work as long as three weeks without some symptoms of sickness. The fumes from pouring and from the cooling mines and shell were very heavy. He himself hardly ever came in actual contact with T.N.T., but he was frequently overcome with dizziness, headache and weakness if he had to stay in the fumes for many hours at a time. It is, of course, by no means certain that these fumes contain only T.N.T. and not some other substances equally toxic or more so.

## Influence of Race

The only students who had any opportunity to observe the difference between whites and negroes in their behavior toward T.N.T. were TeLinde in Virginia and Herman and Putnam in Pennsylvania. TeLinde was much impressed by the greater susceptibility of the white men. He did not find one case of T.N.T. sickness among the negroes. Negroes who were working alongside the whites handling

amatol sometimes gave a moderate Webster reaction, but their urines were normal in color, not dark, as were the urines of many of the white men in this department, nor did they complain of any symptoms of poisoning. In sifting pure T.N.T. by hand, only negroes were employed, and although the dust here was excessive, they gave a slight Webster reaction or a negative one. It is true that this dust was pure T.N.T. but that was also true of the dust in the drilling department in one of Alice Hall's plants, yet she found decided evidence of poisoning among the white men employed there and always got positive Webster reactions. On the other hand, Herman and Putnam, who were able to watch negroes and whites working together throughout the plant, found no difference in susceptibility of the two races. They examined thirty-seven whites and thirteen negroes. Among the latter were some who showed marked poisoning; indeed, the most typical case of T.N.T. poisoning that came under their observation was in a negro. They also found several negroes entirely unaffected after comparatively long periods of exposure.

It was apparent from TeLinde's report that the negroes in the Virginia plant were neither living nor working under the same conditions as the whites. They were, on the whole, more in the habit of taking baths than were the mountain whites employed there, and, living in their own cabins, they had a diet rich in fresh vegetables and fruit, while the white men ate in the company canteen where the diet provided was largely meat and canned vegetables, with almost no fresh food. In the Pennsylvania plant the negroes and whites not only worked in the same departments, but lived in company bunk houses and ate the same food. Both races had about the same standard of cleanliness and both had T.N.T. poisoning. There is, therefore, no indisputable evidence of racial immunity toward T.N.T. as a systemic poison, although negroes are distinctly less liable to T.N.T. dermatitis, as was found in both plants.*

In this respect our experience agrees with that of the French in their munition plants (8). The French employed three races, white, yellow and black, in making and loading dinitrophenol, and at first were impressed with the greater resistance of the Anamites, the yellow race, and the high degree of susceptibility of the white race. Later, however, they discovered that if all conditions were taken into consideration the theory of racial immunity became decidedly questionable. The white men were more intemperate, more uncleanly in their habits, and less obedient to shop rules than were the yellow men, and in addition, the best medical care, which means the most careful examination and diagnosis, was given to the white men. These differences seemed to the French enough to account for the difference in the numbers of cases of D.N.P. poisoning reported from the two groups.

## Influence of Age

Forty per cent. of the employees in the six American plants studied were under 25 years of age, and 22 per cent. under 21 years. The largest proportion of youthful employees — 55 per cent. under 21 years of age — was in Plant 3, fortunately one of the better plants. Miss Hall reported a very marked susceptibility among the younger men under her observation. Only a few men under 25 years were employed in her two plants, but the few that were under that age showed a very low resistance to the poison. Three lads of 19 were dis-

* Marshall, Lynch, Smith, and Williams of the Chemical Warfare Service tested the susceptibility of whites and negroes to mustard gas. A certain degree of resistance was displayed by about 20 to 40 per cent. of the whites, and by 78 per cent. of the negroes. Two per cent. of the whites showed hypersensitivity, but none of the negroes. (G. S. Derby, *Arch. Ophth.*, 1920, 49, 119.)

charged after three weeks' work, because the doctor was unwilling to take the risk of keeping them longer. One man of 21 years, who was unusually careful and cleanly in his habits, sickened so seriously at the end of the first week that he was discharged. Of all the men who were discharged from the worst of these two factories during one month on account of sickness, one-third were under 25 years of age, while only one-eighth of the entire force employed were under 25.

None of the other students had any such striking incidents to report; indeed, they were not impressed with the oversusceptibility of the younger men, but a close analysis of their records demonstrated it. For instance, forty-eight of TeLinde's cases were divided into two groups, one consisting of twenty-nine lads under 21 years; the other, of nineteen men over 30 years. The period of exposure to T.N.T. before the appearance of the first symptoms of sickness was noted in each case, and it appeared that while the older men had averaged forty-nine days of work before sickening, the younger men averaged only ten and a half days. The young men had for the most part reacted to the T.N.T. with great rapidity, only five out of the twenty-nine working as long as two weeks without feeling any effect. Similar groups from Eversoll's records gave an even greater contrast. The older men averaged fifty-six days' exposure, the younger men only seven to eight days.

Finally, I selected at random from the history sheets of these two plants fifteen records of men who had developed serious symptoms in a very short time, and on referring to the age lists I found that only one of these fifteen was over 21 years of age, and he was only 24 years old. Yet in these two plants the men under 25 years constituted less than 40 per cent. of the force. The early experience with T.N.T. in England showed clearly the greater susceptibility of the young people. The general mortality from toxic jaundice, recognized and notified as such, was 25.9 per cent., but for persons under 18 years of age the proportion was six deaths out of nine cases (3).

### Influence of Sex

The British reports have not shed any light on the question of the influence of sex in T.N.T. poisoning. Although the mortality among the women was greater than among the men — 28.6 per cent. as against 20 per cent. — the women were younger than the men, and the oversusceptibility is attributed by Legge to their youth, not to their sex. We could not come to any conclusion at all with respect to the American cases, since the employees in our plants were almost all men, and the few women employed did relatively safe work. It was possible to obtain records of only thirty-six women employed in four shell-loading and detonator departments. These women were carefully examined, but the results were largely negative. None of them was doing any of the more dangerous work, such as preparing the charge, loading shell or drilling the hole for the detonator charge. Indeed they would have had little or no contact with T.N.T. had they all been employed in well-regulated plants, but sixteen were working in the two plants under Miss Hall's observation where T.N.T. was so recklessly spilled and scattered about that it was impossible to avoid contact with it. Miss Hall examined a group of seven women whose hands were stained from handling shell smeared with T.N.T. Five complained of mild symptoms and three of these gave positive Webster reactions, but none showed cyanosis, and none had applied for treatment, except one married woman who complained of nausea and vomiting, and whom the physician believed to be pregnant. Miss Hall examined another group of nine girls who were pressing

small quantities of dry, pure T.N.T. into detonators. Only one, a girl of 20 years who had worked six weeks longer than any of the others, had fairly serious symptoms. A third group, under TeLinde's observation, working under good conditions and exposed to small quantities of fume and dust had no signs of ill health, although two of the women had Webster reactions of medium intensity. Miss Emery examined ten women who were obliged to come more in contact with amatol than any of the other women, for they were cleaning the outer surface of loaded shell, cleaning the threads of the screw necks, and placing the finished shell in cars. Six of these ten suffered from T.N.T. dermatitis and slight symptoms of systemic poisoning. One of them, a woman of 31 years, seemed unusually susceptible. She had an eruption over her hands, arms and legs, and complained of nausea, loss of appetite, constipation, sore throat and pains in her legs and arms. None of these women was cyanosed.

Summing up, we may say that it was even more impossible to compare the susceptibility of the two sexes to T.N.T. than to compare the susceptibility of negroes and whites, for the exposure of the women and the men was altogether different.

## Effect of Hot and Humid Weather

Every manager and foreman interviewed said that T.N.T. poisoning was more common and severe in hot weather, especially if the humidity was also high. The students in charge of the inquiry, with the exception of Herman and Putnam, worked through the intense heat of August, and all of them reported that the number of cases of sickness increased markedly during the hot days and for a few days just following. Miss Hall wrote that only four men came for treatment during six days when the temperature was between 68° F. and 89° F., but in six days of heat from 90° F. to 106° F. twenty men reported for treatment, and this number did not represent nearly all of the sickness, because on the day of greatest heat the plant was obliged to close down for lack of men and was greatly hampered for two days more.

Curiously enough, heat does not seem to increase T.N.T. dermatitis, contrary to the general impression that prevails among the men. It is true that summer is the season for "T.N.T. itch," but the excessively hot weather of August did not increase the number of cases as it increased the cases of systemic T.N.T. poisoning. There were quite as many cases in cool summer weather as in hot, and the probable explanation for the increase of "itch" in summer is that the men expose more of the skin by rolling up their sleeves and leaving their shirts open at the neck, or by working in low-necked and sleeveless underwear.

## Period of Exposure before Absorption Takes Place

The Webster reaction may appear very early, especially if there is excessive exposure. Miss Hall reported the most striking cases of rapid absorption and elimination of the poison and I have already spoken of the appearance of a positive Webster in her urine after a few hours' sojourn in a badly contaminated department. Miss Hall was able to get reactions of medium intensity in the urines of ten newly employed men at the end of their first six hours of work. Such excessive exposure did not exist in any other plant, but the records of 133 cases in which a maximum Webster reaction was obtained showed that more than a third of the men, 39 per cent., had been exposed no longer than three weeks.

There were plenty of records of men who felt the first symptoms of illness on the first or second day of their employment, but sometimes these symptoms passed away

and the men felt quite well again for a short time; then, after longer exposure, symptoms of another kind developed. TeLinde and Herman and Putnam described in some cases a transitory disturbance of digestion with loss of appetite, a bad taste in the mouth, and usually diarrhea with more or less pain, but no cyanosis or dizziness or headache. The more characteristic symptoms were breathlessness, a feeling of tightness in the chest, headache, dizziness, dullness and lassitude, pains in the limbs, weakness of the knees and lividity of the face with blue lips, and these usually appeared soon after the beginning of T.N.T. work. Even in a well-managed plant the men who were at all susceptible to T.N.T. felt the first symptoms fairly early, nearly a third of them before the first fortnight was over.

It is the general belief of the men who have had experience in T.N.T. work and of some plant physicians that T.N.T. dermatitis is quite distinct from general poisoning and that a man with "the itch" never need fear an attack of serious T.N.T. sickness. The students found several exceptions to this rule. Nine out of twenty-eight patients with dermatitis in the Wisconsin plant had fairly serious general symptoms of poisoning, as did four out of twelve in the Virginia plant. It is clear, however, that an attack of dermatitis may occur from a purely local action of T.N.T. or its impurities, for the majority of the men with dermatitis had negative Webster reactions or very slight reactions.

### Persistence of T.N.T. in the Body

It was, of course, a matter of great practical importance to determine how quickly T.N.T. could be eliminated from the body, and the students were, therefore, instructed to make repeated Webster tests on the urines of men who had been shifted from T.N.T. work or who were in the hospital under treatment. They found that the reaction tended to disappear from the urine within a fortnight after entire removal from T.N.T. work, but that there were instances of delayed elimination quite as striking as the instances of rapid absorption. One of Miss Hall's patients, who was seriously poisoned and gave a Webster 5, was removed from all exposure to T.N.T. but after twelve days it was still possible to get a positive reaction. TeLinde reported a case with positive Webster reaction five weeks after removal from work.

Eversoll and TeLinde were the only students who were able to send full records because the plants under their observation were the only ones in which there was a regular system of shifting men to work free from T.N.T., and keeping them under observation. The most rapid instances of partial and complete disappearance of the Webster reaction came from TeLinde who was able to observe men in the plant hospital where a vigorous eliminative treatment was carried through. The men with T.N.T. sickness were given a thorough scrub bath, a purge, an enema, and a diuretic, and were encouraged to drink large quantities of warm milk. Under this treatment the poison was eliminated fairly rapidly. One boy of 18 years, who had never been sick before, was first examined after he had been exposed to fumes and dust for thirty-five days. He had a Webster 3 at that time. Six days later he came to the hospital with typical symptoms of acute poisoning and a Webster 5. Under the above treatment the reaction fell in thirty-six hours from 5 to 1, and his symptoms had improved greatly, though they had not disappeared. Another man with much the same symptoms, as well as abdominal pain and diarrhea, had a Webster 4 which in twenty-four hours fell to a trace.

Both TeLinde and Eversoll found that a transfer to work free from T.N.T. would re-

sult in a disappearance of the Webster reaction, but much more slowly than under hospital treatment. One of Eversoll's cases was transferred to outdoor work on July 21 because of slight symptoms of poisoning and a Webster 4, but he did not give a negative Webster till August 31. Usually the work to which the man was shifted involved some slight contact with T.N.T., in which case the reaction would persist. An interesting case reported by Eversoll was in a boy of 18 who, because of decided symptoms of poisoning and a maximum Webster, was put on outdoor work every other night. On the morning after such work the reaction would be Webster 1, but on the morning after his shift of pouring T.N.T. it would be Webster 3. A pelleter who had a Webster 4 was transferred to the nitrating department, where there is very little contact with T.N.T. The reaction fell to 3 in six days' time, then gradually to 1, where it persisted. A striking argument in defense of the contention that clean working clothes, clean gloves, and good bathing facilities must be provided for these men was found in the persistence of the Webster reaction in men who continued to wear their dirty gloves after being shifted to T.N.T.-free work. TeLinde had several instances of men with persistent Webster 1 or Webster 2 reactions, even after transference to the empty-shell department, and he came to the conclusion that they were absorbing small quantities of T.N.T. from their soaked gloves.

## Comparative Danger of Crude, Pure and Mixed T.N.T.

In dealing with this question also we were greatly hampered by the varying conditions in the different plants. Miss Hall saw severer cases of poisoning in men loading pure T.N.T. than TeLinde saw in men loading amatol, but in the one case the exposure was excessive, in the other, slight. The negroes in TeLinde's plant certainly showed greater absorption of amatol than of pure T.N.T., those working with amatol giving positive Webster reactions up to 3, while those working with pure T.N.T. gave negative or 2 as the highest reaction. We were not able to say whether more poisoning resulted from crude T.N.T. than from pure T.N.T., or *vice versa*. According to the experiments of Voegtlin and his colleagues (9), there is no difference between crude and purified T.N.T. so far as their effect on animals was observed. The only positive fact that we were able to establish was that crude T.N.T. is more productive of dermatitis than the purified. We had looked for the greatest incidence of eczema and other skin lesions in the dirty, loading plants in the New Jersey meadows, where heat and humidity, excessive exposure, and poor washing facilities would seem to favor it. Instead, it was found that those very plants had the smallest number of cases of T.N.T. itch, and the largest number occurred in the two cool situations, the nitrating plant in northern Wisconsin and the purifying plant in the Pennsylvania mountains. Since the Wisconsin plant was not only the coolest, but was one of the cleanest, had excellent lavatories and employed an unusually high class of labor, it is plain that there must have been something in the material handled that was responsible for the high percentage of dermatitis.

The following figures show the proportion of itch among the men and women in these six plants. It is evident from them that crude T.N.T. is worse than the pure, and that amatol is worse than the unmixed.

| | Percentage of Men with T.N.T. Dermatitis |
|---|---|
| Plants 1 and 2, loading pure T.N.T. | 3.4 |
| Plant 3, loading amatol . . . | 18.0 |
| Plant 4, loading amatol | 20.0 |
| Plant 5, purifying crude T.N.T. | 26.0 |
| Plant 6, manufacturing crude and pure T.N.T. . . . | 31.0 |

### Early Symptoms of T.N.T. Poisoning

Most of the students reported that the first symptom noted by the men was breathlessness on exertion, especially on climbing a hill or going upstairs. A man who said that he had not felt the effect of his work in any way would almost always admit this symptom if he was asked. Next in order came dizziness on stooping over, and more or less persistent headache, or the man complained first of loss of appetite, bad taste in the mouth, and a sensation of nausea in the morning. Sometimes the men who were exposed to dust complained of running of the eyes, smarting and burning in the nose and throat, and nose-bleed. Together with these symptoms, an early case of poisoning is characterized by cramps in the calves of the legs, fatigue disproportionate to the work done, and a feeling of tightness in the chest. Very early in the course of poisoning the man notices a change of color in the urine. It is a clear brown, at first about as dark as weak tea, then increasing till it may be as dark as coffee.

By the time the man feels ill enough to go to the doctor for treatment, he presents a very characteristic appearance. He has an expression of dullness and weariness, heavy eyes, drooping lids, sclerotics slightly yellow, lips and mucous membranes of the mouth blue, the face a leaden or ashen color. In Plant 1, patients with very livid color and lips almost inky were described by Miss Hall.

So far as one can judge from the notes of the students, there did not seem to be two clearly marked varieties of T.N.T. poisoning, the gastric and the cyanotic, such as have been described by some of the English writers. In Plants 3 and 5 a mild gastric form without cyanosis was noted, but these cases cleared up rapidly. No serious gastric case was free from cyanosis, and almost all of the patients with cyanosis, dizziness, faintness, headache and pain in the limbs, showed gastric symptoms also.

When no effort was made by the physician in charge to discover cases of sickness among the men, it sometimes happened that by the time a workman applied for treatment he was already severely poisoned, for apparently serious changes may occur without causing enough suffering to make the man believe that he is really sick. Miss Hall saw a man in the dispensary who had not come to complain of sickness, but of an infected cut. She described him as being strikingly pale, with a grayish yellow color, his lips, ears and tongue deeply cyanosed, and his sclerotics distinctly yellow. He had dyspnea and a pulse of 100. His urine was brownish black and gave a Webster 5, yet on questioning him, she found that he complained of nothing except breathlessness and a slight headache. He was told to return to have the cut dressed every day, but he did not, and when Miss Hall finally discovered his lodging house a week later she was told that he had been sick in bed for four days and had then left for the city. This is a good illustration of the wastefulness caused by poor medical supervision.

The effect of alcohol on T.N.T. poisoning was well known to the workmen in the plants studied. They knew perfectly well that while working with T.N.T. they could not drink without risking serious sickness. Many stories were told of men turning blue in the face and falling unconscious on the floor of a saloon after one or two drinks of whiskey. So notorious was this that the men who wanted to keep on working practically gave up drink, or if they decided to go on a spree they would deliberately lay off work for two or three days before and two or three days after. They described the effect as a sudden, intense flushing of the whole body, with a sensation of heat, a rush of blood to the head, blackness before the eyes, and then loss of consciousness.

Bystanders reported that during the period of complete collapse, the affected man's face was livid and his lips an inky blue.

It was a matter of great surprise to us not to discover a single case of typical toxic jaundice nor of aplastic anemia in any one of these five plants during the time the students were working there. Miss Hall was told that a young girl of 16, who had been working for three months, left on account of sickness and was at that time so deeply jaundiced as to attract attention. She died two weeks later, but it was impossible to trace this case or to secure any information from the physician. It is difficult to explain the absence of toxic jaundice. During 1916, I had found records of thirteen deaths from T.N.T., eleven of them typical toxic jaundice, and there was a much larger number of men employed in 1918 than in 1916. The only explanation that can be given is that in three of these plants medical supervision was careful enough to make it impossible for a case of poisoning to progress to the point of severe jaundice, while in two other plants, all sick men were promptly discharged, and no one knew what happened to them afterward. It must also be remembered that the men were usually exposed to T.N.T. for a very short time only. Out of 374 men, only fifty-seven had worked for more than three months, and British statistics show that toxic jaundice usually does not appear before three months' exposure. In one of the plants, the proportion of those employed as long as three months was only 4 per cent.; in another, 7 per cent.; and in all the labor turnover was very great, decidedly greater than in 1916. Reports did indeed come to me of toxic jaundice and of aplastic anemia in other T.N.T. plants. I had reason to believe that there were twelve or thirteen cases during the last year of the war, but none were in the factories where the students were stationed.

### Significance of the Webster Reaction

The Webster reaction seems to be an admirable test for the absorption of T.N.T., a very rapid and delicate one. The worse the plant is, the larger is the proportion of positive Webster tests. In Plant 1 every urine examined was positive, even if the man had been at work only one day. In Plant 4, which had the best conditions, there were only twenty-one negative reactions out of ninety-eight specimens. As an index of absorption it is certainly valuable. Repeatedly, the intensity of the reaction increased as the days went on. Herman and Putnam applied the tests in about half their cases before and after work, and in about 90 per cent. of these cases the reaction was more intense after an eight-hour shift than before it. The work in this plant was continuous, no holidays or Sundays being observed, but in the others, where the Sunday rest was given, it was repeatedly found that the Webster reaction would be low on Monday and rise gradually to be high on Thursday, Friday and Saturday.

Whether the Webster test is of any other practical value is hard to say. It could not be used as an indication that an acute attack of poisoning was impending, nor was it possible to establish a correspondence between the clinical history and the Webster reaction. While, as a general rule, the intensity of the reaction increased with the increasing severity of an attack, there were too many exceptions to this rule to make it of any practical value. Serious cases sometimes occurred with only a slight Webster reaction, while, on the other hand, a Webster 4 or even a Webster 5 was found in men who had no symptoms of sickness at all. One man with a negative Webster had gastric pain, nausea, vomiting, weakness in the knees, cramps in the calves of the legs, dermatitis on hands, arms and ankles, and general weakness. According to Feldman (10), the Webster reaction, indicating as it

does elimination of T.N.T., should not increase with the onset of severe symptoms, but should diminish or disappear, and Feldman had an opportunity to observe just this phenomenon. The students were asked to bear this possibility in mind and report on it, but Miss Hall was the only one who saw a case with a drop from Webster 3 to 1 as symptoms of poisoning developed. A careful analysis of 137 cases failed to bear out Feldman's theory, for in general the more intense Webster reaction is associated with the more serious form of poisoning.

As a rule Websters 4 and 5 were found among the newly employed, those who had worked less than a month, while the men who had handled T.N.T. for six months and more hardly ever had a reaction of more than 2 or 3, showing that a gradual elimination of the more susceptible men takes place, those that absorb the poison readily dropping out while the relatively immune remain at work.

## Value of Blood and Urine Examinations in the Diagnosis of T.N.T. Poisoning

The examinations made of the blood have been described in detail by Dr. George R. Minot (11), who found a blood picture of enough definiteness and frequency to serve as a valuable guide in the diagnosis of T.N.T. poisoning and in the estimation of the degree of severity of poisoning. As already shown, the Webster reaction cannot give much aid in this respect, but it seems probable that further studies on the urine will bring to light other substances besides the reduction product of T.N.T. which is responsible for the Webster reaction. Certainly it seemed to the students that the changes of color in the untreated urine bore a closer relation to the clinical history of the case than did the varying intensity of the Webster reaction. This color was usually clear light brown to blackish brown and was quite independent of the elimination of T.N.T. as shown by the Webster reaction. Nineteen specimens of dark brown urine, for instance, were either negative to the Webster test or almost negative, while eight which gave a Webster 3 or 4 were normal in color. In one of TeLinde's patients, a man who was shifted from T.N.T. work on account of sickness, the Webster reaction fell from 4 to a trace, while the dark brown color remained unchanged. Two more of his cases dropped to a negative Webster with persistent dark color, while a fourth had a Webster 4 continuously with a normal color. As was to be expected, the darkest specimens came from Plants 1 and 2. Miss Hall reported twenty-five very dark urines, some of them the color of tincture of iodine. She was never able to detect bile in these specimens nor were Putnam and Herman able to do so in theirs.

In some cases the urine changed from a brown to a clear red color, while in others it was red when the first examination was made. These red urines were always associated with a high Webster and with clinical symptoms of poisoning. Among seventy-four specimens, TeLinde found fifteen normal, eight red, and fifty-one brown. Miss Emery found ten normal among forty-seven, nine red, and twenty-eight brown. These observations should, of course, have been supplemented by chemical and microscopic examinations but we did not pursue them further because the Hygienic Laboratory of the Public Health Service had undertaken an intensive study of T.N.T. urines and we did not wish to duplicate their work.

## Summary

The studies made by these students served to emphasize certain practical points in the prevention of T.N.T. poisoning which in all probability apply with

equal force to those nitro and amido derivatives of the benzene ring that are used in the dye and drug industry.

T.N.T. is absorbed chiefly through the skin and, therefore, the most important part of the prevention of T.N.T. sickness is the protection of the worker against direct contact with it. The methods of manufacture, whether or not they necessitate hand work, the cleanliness of the work benches, apparatus, trucks, etc., and the prevention of dust are all of more importance even than the provision of good washing facilities, because a man can wash only at the noon hour and on quitting work, and in the time between these periods he may have his hands and arms continually smeared with T.N.T.

Next in importance to cleanliness of the premises comes the provision of clean working clothes, socks, and gloves. The students' examination showed that T.N.T. could probably be continually absorbed from dirty gloves and dirty overalls. The necessity for providing ample washing facilities, hot and cold running water, soap and towels, and the time to use them, is emphasized, not because it is not perfectly obvious in connection with such a poison as T.N.T., but because it was ignored in several of the T.N.T. plants during the war and is ignored in some of the coal-tar dye works at the present time.

Fumes from melting pots are apparently capable of causing typical T.N.T. poisoning, as is also steam from washing and pelleting, but the more serious forms of T.N.T. sickness are probably never caused by fumes alone.

Hot, humid weather increases general T.N.T. poisoning, but not T.N.T. dermatitis. This last is more prevalent in summer than in winter, but is not increased by very hot weather. Its increase in summer is probably due to the greater exposure of the skin in warm weather.

Young men are more susceptible to T.N.T. than fully grown men. They succumb more quickly and apparently suffer more seriously. It seems poor economy to employ them.

Negroes are not susceptible to T.N.T. dermatitis and may be less susceptible to systemic poisoning than whites, but evidence on this point is not complete.

The application of the Webster test to the urines of approximately 400 T.N.T. workers showed that T.N.T. is rapidly absorbed, but that it can also be rapidly eliminated. Some men could eliminate overnight what had been absorbed during the day; others could get rid of the week's accumulation during Sunday and start on Monday with the urine free from the reduction product. The danger of overtime work and of the seven-day week was shown by these observations and also the value of an occasional vacation of two or three days.

By the use of these same tests it was found that the most economical way to deal with a worker who had absorbed a large amount of T.N.T. was to suspend him altogether from work and subject him to vigorous eliminative treatment. Simply to transfer him to less dangerous work was to postpone his recovery.

No positive aid in the diagnosis of T.N.T. poisoning was found in the Webster reaction in the urine, but the color changes in the untreated urine seemed more significant and worthy of further study. The blood changes found by Dr. Minot are important enough to lead one to hope that careful blood examinations made in workers who are exposed to other benzene derivatives may give similar results, and thus an important aid be gained in the diagnosis of similar forms of industrial poisoning.

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# DOES THE MAGNETIC FIELD CONSTITUTE AN INDUSTRIAL HAZARD?*

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MEN achieve undeniable enjoyment and comfort from attributing misfortune and disease to influences which they do not understand. Thus, there is a large group who are quite satisfied with astrological explanations for an epidemic of influenza, and in times past there have been even larger groups whose ideas of disease rested upon a jumble of electromagnetism and fictitious forces of human magnetism, all so vaguely considered as to be entirely mystifying and, therefore, entirely satisfying. One might write at length of individuals who thus are happy in explanations which are not hampered by efforts to seek the truth.

In view of the frequency with which mystifying phenomena have been described as causal agents, it is not surprising that even within fairly recent years many extraordinary physiological effects have been claimed for the magnetic field; even in serious discussions the possibility that the field may effect cures of nervous disease has not been overlooked. Our attention was drawn to the subject in the course of investigations upon chronic poisoning by manganese (1). The affected workmen had, with few exceptions, been exposed to strong magnetic fields and the question — already suggested by Casamajor (2) — arose as to whether these exposures might not have something to do with causing the symptoms observed. The poisoning in question occurred in men working in an atmosphere heavily laden with ore dust, much of which was strongly attracted by the magnet, and the questions arising were of two sorts:

1. Is it possible that particles of manganese-bearing mineral deposited in the body are caused to penetrate more rapidly if the individual carrying them passes in and out of strong magnetic fields?

2. Does the magnetic field alone in very great strengths produce any measurable physiological effects?

The first of these questions we have never attempted to answer since a progressive reduction of dust, in the neighborhood of the large magnetic separators used in the mill involved, rendered it of no direct importance. The second question offered an opportunity to test the effect of stronger magnetic fields than have ever been used in biological work, and we were, accordingly, interested in undertaking to find an answer to it. The results, though entirely negative,

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are given in some detail in order to establish thoroughly the harmlessness of work in the neighborhood of extremely powerful electromagnets.*

Hermann (3), in a paper published in 1888, discusses previous scientific work with the magnetic field, together with the vast amount of charlatanry which has grown up around "magnetism" as a result of the use of magnets by hypnotists and others, and gives also an account of physiological experiments carried out by himself. Readers interested in the earlier literature on the effect of the magnetic field are referred to this paper. Under appropriate conditions Hermann found that certain fundamental properties of muscle and nerve were unaffected by exposure to magnetic fields. Unfortunately, however, he gives no information as to the actual field strengths operative in his experiments. This same criticism applies to other biological work with the magnetic field, the observations of Peterson and Kennelly (4) being excepted.

In 1892, Peterson and Kennelly made experiments with magnets in the Edison Laboratory at Orange, New Jersey, in order to test out extravagant claims then current as to the therapeutic effect of the magnetic field. A quotation from the paper of these investigators will illustrate the degree to which magnetism commanded attention at that time (4).

The status of magneto-therapy in America may be inferred from some quotations from the third edition of Roberts Bartholow's *Medical Electricity*, 1887. Under the caption of Physiological Effects of Magnet Applications he says: "We know that a current circulates in a magnet. If a powerful horseshoe magnet is brought near to the skin, opposite electricities are attracted to the poles and currents are induced. About the point of application, therefore, the skin will be acted on directly by the magnetic current and by an induced current. The production of physiological effects, which can be recognized, is therefore merely a question of the magnetic strength."

He then quotes Dr. Vansant as assuming the body to be diamagnetic: "By applying north and south polarity to different parts, very extensive subjective impressions are experienced; they are of two classes — of heightened organic activity, and the opposite condition."

He then adds: "That impressions of a very decided kind are produced by the application of strong magnets is evident in the experience of Dr. Proust and Dr. Ballet, who continued a course of investigation begun by Charcot at Salpêtrière." They ascertained that magnets could not be applied with impunity, for, if applications were prolonged, pains were felt in the epigastrium and thorax, making respiration painful, digestion was disordered, and boulimia brought on. These results were so uniform that there seemed to be no doubt of their genuineness in the minds of the investigators.

In their first experiments, Peterson and Kennelly employed a magnet with a field intensity of 5,000 c.g.s. lines per square centimeter. They tested this field upon dried hemoglobin, fresh blood, ciliated epithelium, and the capillary circulation, without observing the slightest effect. They then placed a dog for five hours in a field with a strength of 1,000 to 2,000 c.g.s. lines per square centimeter without observing any change in the animal; and, finally, they tested the effect of field strengths of 2,500 c.g.s. lines per square centimeter upon themselves. In these latter efforts a variety of types of exposure were used but all resulted negatively, justifying their conclusion that the human body is apparently quite uninfluenced by magnetic fields of moderate strength.

Pfeffer (5), in 1903, discussing the possible actions of the magnetic field upon growth, can find no convincing evidence that any effect has been obtained. Ewart (5), in an editorial note, suggests that this is possibly due to weakness of the fields employed and that theoretically one should be able to affect living protoplasm provided strong enough fields are used.

* These experiments were made possible by the New Jersey Zinc Company through the loan of one of their large electromagnets of the type employed in the process at Franklin Furnace, New Jersey.

In all the experiments mentioned so far, with the exception of several by Peterson and Kennelly, a continuous current was used and the field strength was steady and unvarying. This condition is also true of the industrial situation which we have cited. In the case of solenoids traversed by alternating currents an interesting type of actual physiological effect was noted first by d'Arsonval (6) in 1893, and has been commented upon by several later experimenters (7) (8) (9) (10). Many of these observations, as for example those of Sylvanus P. Thompson (11), are considered by their authors to be the first note of the phenomenon ever made. That a definite and easily obtainable physiological effect does, therefore, arise in the neighborhood of a sufficiently powerful alternating field cannot be doubted. If the head is inserted in a coil or if it is brought close to a coil through which a strong alternating current is passing, a flicker of light is noticed, and this is perceived with the eyes open or closed, and in a dark or a light room. There is apparently no doubt that a definite visual sensation is induced and that it can be made to vary with current strength and the relation of the head to the magnet. Dunlap (12, p. 70) describes the sensation as follows:

> With 480 amperes of 25-cycle current (20 volts) a much more striking result was obtained. With my head below the level of the coil, and with my eyes open, the flicker was strongly noticeable, although the room was brightly lighted by afternoon daylight. The whole visual field quivered as if illuminated by a rapidly intermittent light. Several other subjects made a similar observation, although in some cases the flicker was noticed only in the less illuminated parts of the visual field, as where shadows fell in the room. With the head inside the coil the flicker was so pronounced as to be intensely disagreeable.

There is no explanation of this eye effect but at the same time there is no evidence that it causes damage. We may sum up, therefore, by saying that the scientific literature upon the physiological effects of the magnetic field is negative in so far as the use of constant fields is concerned, and in the case of alternating fields does not contain evidence of an effect which is harmful even when the experimenters employ much more severe exposures than would ever be experienced in any industrial operation.

## Experimental Observations

*a. Magnetic Fields.* — The magnet used was a very large one. The general configuration of the pole pieces and arrangements for exposure of experimental material are indicated in Figure 1a. The pole pieces A and B are permanent, but C and D are adjustable and when in place enable one to secure maximum field strength between their tips. In Figure 1b a muscle M lies to the left of the poles C and D, and the nerve N to the muscle passes between the pole tips through a gap 1 mm. in width.

Field strengths were measured by means of a bismuth spiral. Table 1 indicates the field strengths at points 1 to 10 in Figure 1a with pole pieces C and D in position and with different amperages. The breadth of the most intense field with its center at point 1, immediately between the tips of the pole pieces, is indicated in Table 2.

Two general types of experimental exposure were employed. In the first of these, blood and isolated nerve-muscle preparations were exposed to the greatest field strengths obtainable, such fields obviously requiring use of the magnet under large amperages with the pole pieces C and D in position. By reference to the positions covered in Tables 1 and 2, one can readily arrive at a close approximation of the conditions to which the tissues were subjected. For example, if a nerve-muscle preparation is placed in a moist chamber K of Figure 1b with the nerve crossing the small gap between C and D, it is clear that the nerve impulse set up at the tips of electrodes E and F and passing along the nerve to the

muscle must, if the magnet is activated by a current of 20 amperes, pass a field intensity of 18,725 c.g.s. lines per square centimeter (Table 1), and that the field strengths to which all parts of the preparation are exposed may be told provided the lengths of the muscle and the nerve are known.

The second type of experimental exposure required the use of entire animals

*b. Nerve-Muscle Experiments.* — Since the nerve, when it conducts an impulse, exhibits an electrical change, and since a similar change occurs in muscle just prior to actual contraction, we examined carefully to see whether nerve conduction or muscular contraction suffered as a result of exposure to the strong magnetic fields we could supply. Various types of experiment were

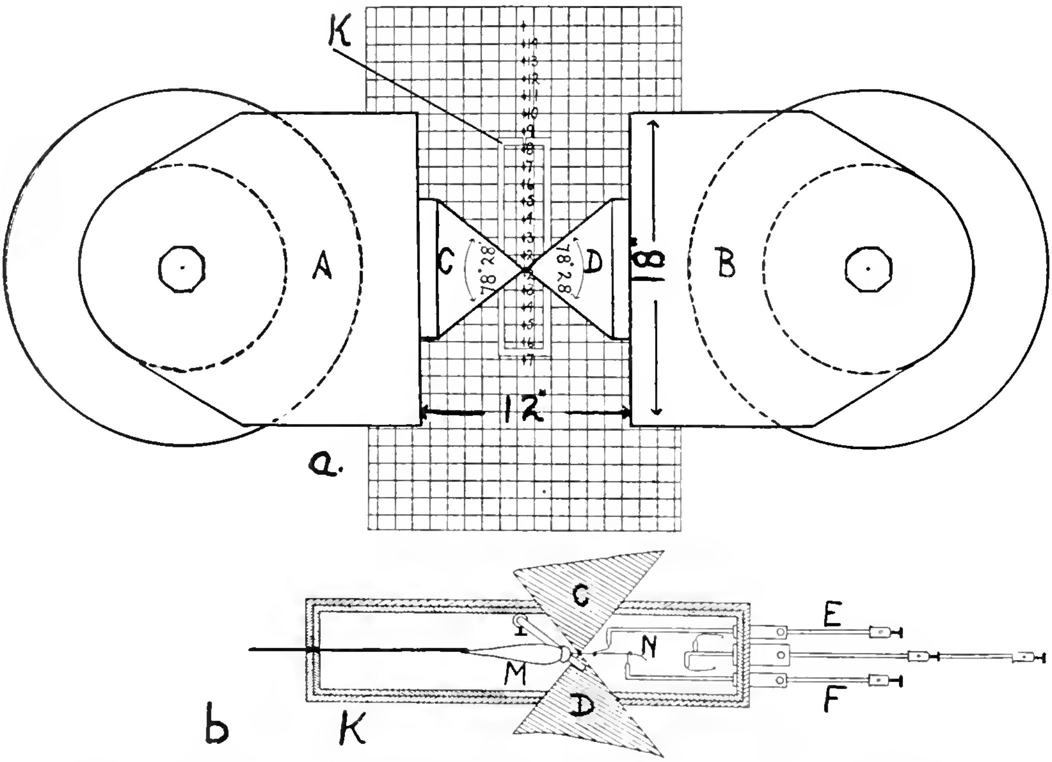


Fig. 1a. — Arrangement of pole pieces A and B, and C and D, with moist chamber K in place. The positions at which magnetic field strengths were determined are indicated by numbers down the center of the field.

b. — Arrangement of nerve-muscle preparation in moist chamber K. M indicates muscle; N, nerve; E and F, stimulating electrodes.

and is described in detail in a later section of this paper. To provide room for these exposures C and D were removed, leaving a large gap, 12 inches by 18 inches. Under these conditions the field strengths obtainable varied in different parts of the gap. Table 3 gives the field intensities at 15 amperes through the center of this field and indicates in an approximate manner the conditions to which animals were subjected over a considerable time.

employed, the ordinary nerve-muscle preparation of the frog and the nerve of the cat being the test objects used. Several examples will suffice to indicate the innocuous character of the field.

Jan. 27, 1919. — Two nerve-muscle preparations (sciatic-gastrocnemius) were made from the same frog. One of these was placed in a moist chamber (Figure 1b) fitted about the pole pieces C and D, which had been lightly coated with paraffin, with

the nerve on electrodes E and F and the muscle clamped in the position shown. From the tendon of the muscle a light silk thread passed out of the moist chamber to a muscle lever lightly weighted and adjusted to write on a large kymograph. The electrodes to the two nerves connected in series in the secondary circuit of an induction coil. The steadiness of the current used in stimulation was controlled by the employment of a milliammeter in the primary circuit of this coil. The thresh-

TABLE 1.—MAGNETIC FIELD STRENGTHS IN C. G. S. LINES PER SQUARE CENTIMETER AT VARYING AMPERAGES IN POSITIONS 1 TO 10, FIGURE 1a, POLE PIECES C AND D IN POSITION

| Amperage | Field Strengths in C. G. S. Lines in Positions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 10 | 17,450 | 8,150 | 4,825 | 3,500 | 2,775 | 2,400 | 2,100 | 1,975 | 1,825 | 1,750 |
| 15 | 18,375 | .... | .... | .... | | | ... | .... | .... | .... |
| 20 | 18,725 | 9,200 | 5,425 | 3,900 | 3,175 | 2,650 | 2,375 | 2,325 | 1,900 | 1,800 |
| 22 | 18,975 | .... | .... | | | .... | .... | .... | .... | .... |

TABLE 2.—MAGNETIC FIELD STRENGTHS IN C. G. S. LINES PER SQUARE CENTIMETER IMMEDIATELY IN VICINITY OF POLE TIPS C AND D AT TWO AMPERAGES, SHOWING DETAILS OF FIELD STRENGTH DECREASE BETWEEN POSITIONS 1 AND 2

| Amperage | Field Strengths in C. G. S. Lines in Positions[1] | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 1a | 1b | 1c | 1d | 2 |
| 10 | 17,450 | 16,375 | 12,750 | 10,100 | 8,400 | 8,150 |
| 20 | 18,725 | 17,950 | 14,200 | 12,075 | 9,625 | 9,200 |

[1] Distance between 1 and 1a = 0.25 inches
" " 1a and 1b = 0.25 "
" " 1b and 1c = 0.25 "
Distance between 1c and 1d = 0.25 inches
" " 1d and 2 = 0.125 "
" " 1 and 2 = 1.125 "

TABLE 3.—FIELD STRENGTHS IN C. G. S. LINES PER SQUARE CENTIMETER WITH POLE PIECES C AND D REMOVED

| Amperage | Field Strengths in C. G. S. Lines in Positions | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 15 | 2,800 | 2,800 | 2,825 | 2,825 | 2,825 | 2,825 | 2,800 | 2,725 | 2,600 | 2,400 |

control muscle was placed in a second chamber lacking the orifices for the pole pieces C and D but in other respects entirely similar, and through a similar muscle lever was caused to write upon the kymograph just above the lever recording the magnetic field muscle. Tight-fitting lids were placed on both chambers and the old stimulus for both preparations was then obtainable by breaking the primary circuit while bringing the secondary coil toward the primary. With the first contraction of the muscles the position of the secondary coil was read, and this represented the minimal or threshold stimulus. Further approximation of the secondary

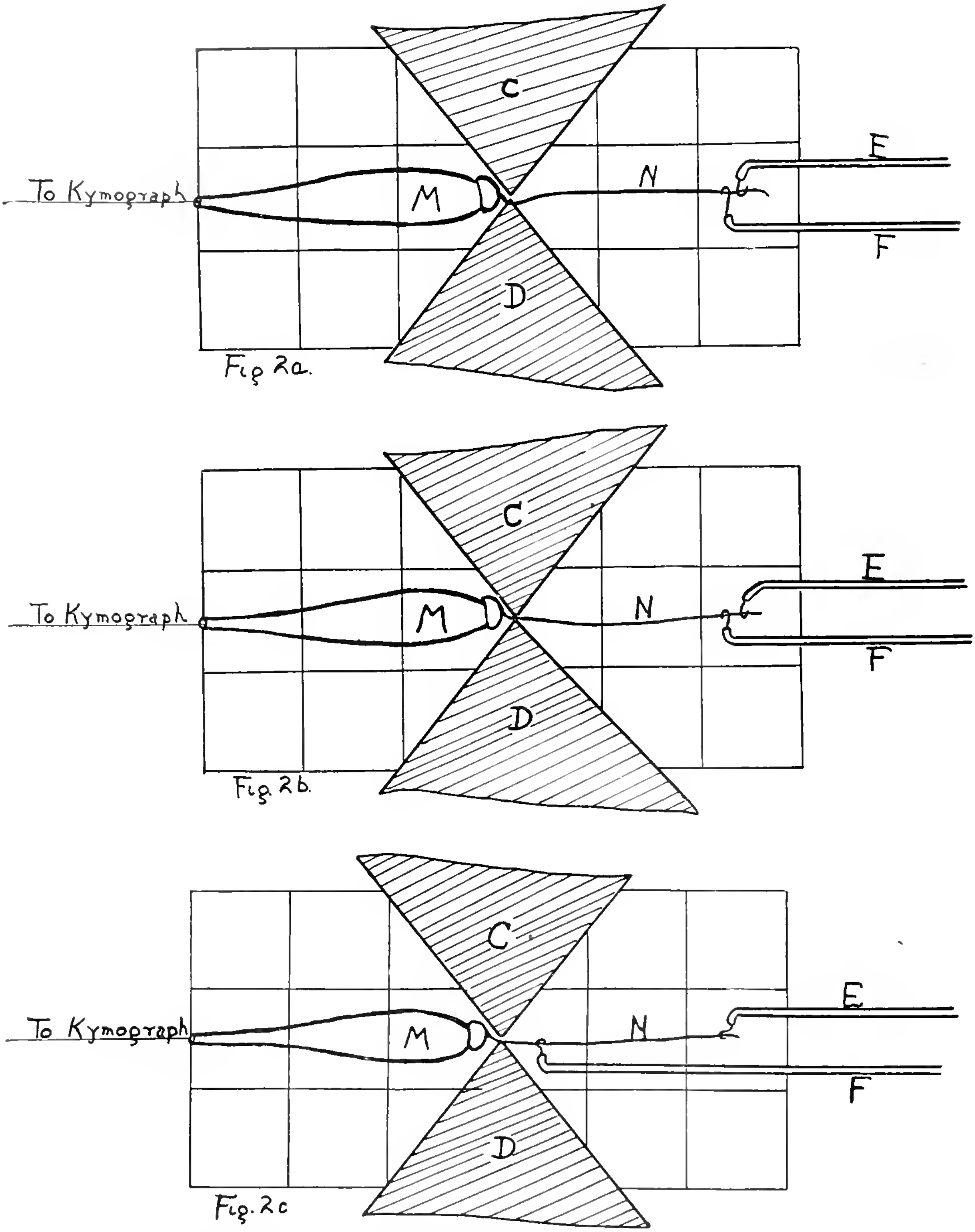


Fig. 2a. — Experiment of Jan. 27, 1919, showing position of nerve N, muscle M, and pole pieces C and D. Electrodes 3½ mm. apart, at a position between 3 and 4; gastrocnemius tendon at 4; and body of muscle between 4 and 1.

b. — Position of nerve after experiment had been in progress four hours.

c. — Position of stimulating electrodes for the last eight hours of the experiment.

coil increased the strength of stimulus and by this means the maximum response was rapidly obtained.

Figure 2a gives the positions of the nerve, the muscle, the stimulating electrodes, and the pole pieces of the magnet in terms of the positions in Table 1. Figure 2b shows a slight variation caused by movement of the nerve during the experiment, and Figure 2c, the final position of the stimulating electrodes. In all cases the positions of the electrodes on the nerve were duplicated in the control preparation.

Figure 3 (p. 127) shows a series of contractions taken simultaneously under identical strengths and conditions of stimulation during the experiment of Jan. 27, 1919. The results of this experiment are summarized in Table 4.

Reference to Table 1 and to Figures 2a, 2b, and 2c will show that the nerve at the original point of stimulation experienced a magnetic field intensity varying between 5,425 and 3,500 c.g.s. lines per square centimeter, that the nerve impulse to reach the muscle had to cross a field of 18,725 to 17,450 c.g.s. lines per square centimeter, and that the contracting muscle lay in a field varying between 18,725 and 3,500 c.g.s. lines per square centimeter. The total period of exposure was from 11.46 A.M. to 5.29 P.M. on the next day, or twenty-nine hours and forty-three minutes. During this period the threshold for conduction of the nervous impulse was tested 116 times and, although the nerve exposed to the magnetic field ceased to conduct before the control, the difference is of no consequence in the face of such a long period of survival. It will be noticed by reference to 49 and 50, Figure 3, that at the end of the first twenty-one hours and before the stimulating electrodes were moved the preparation which had been in the magnetic field was in better condition than the control. When the electrodes were moved a difference in behavior resulted, but throughout the experiment the entire course of events was not different from that obtained when two nerve-muscle preparations are set up under identical conditions. In order to be entirely sure that this interpretation was correct the experiment was repeated eighteen times, but no trace of magnetic field effect was ever obtained.

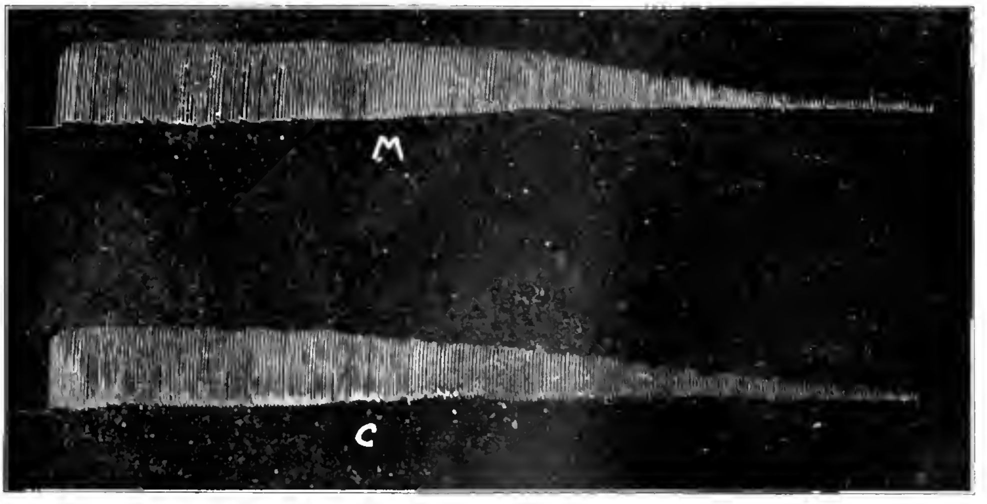


FIG. 4. — Fatigue curves written by companion nerve-muscle preparations under identical conditions of stimulation. C indicates control muscle; M, muscle exposed to magnetic field.

A second type of experiment is illustrated in Figure 4. In this case two nerve-muscle preparations were set up as in the

TABLE 4.—THRESHOLD STIMULI OF MAGNETIC FIELD AND CONTROL MUSCLES DURING THIRTY HOURS

| Time | Temperature | Current in Primary Circuit Inductorium | Magnet Circuit | Observation No. | Threshold Stimulus in Scale Divisions | |
|---|---|---|---|---|---|---|
| | | | | | Magnetic Field Muscle | Control Muscle |
| *January 27* *A.M.* | °*C* | *Amperes* | *Amperes* | | | |
| 11.30–11.32 | 17.2 | 0.075 | ... | 1 | 21.0 | 29.0 |
| 11.44–11.46 | ... | 0.075 | ... | 2 | 21.5 | 28.0 |
| 11.46 [1] | ... | ... | 20.4 | ... | ... | ... |
| 11.51–11.53 | 17.0 | 0.075 | ... | 4 | 21.0 | 29.0 |
| 11.58–12.00 | ... | 0.072 | ... | 5 | 21.0 | 28.0 |
| *P.M.* | | | | | | |
| 1.48 | ... | ... | 18.6 | ... | ... | ... |
| 2.56–2.58 | ... | 0.072 | ... | 30 | 20.0 | 26.5 |
| 3.11–3.13 | ... | 0.072 | ... | 31 | 20.5 | 26.5 |
| 3.27 | ... | ... | 18.6 | ... | ... | ... |
| 4.10 | ... | ... | 18.6 | ... | ... | ... |
| 4.59 | ... | ... | 18.2 | ... | ... | ... |
| 5.18–5.20 | ... | ... | ... | 49 | 19.0 | 23.0 |
| 5.25–5.27 | ... | ... | ... | 50 | 19.5 | 24.0 |
| 5.27 [2] | ... | ... | 10.0 | ... | ... | ... |
| *January 28* *A.M.* | | | | | | |
| 8.47 | ... | ... | 15.0 | ... | ... | ... |
| 8.47–8.49 [3] | 12.2 | 0.069 | ... | 51 | 6.5 | No contraction obtainable. |
| 10.07 | ... | ... | 19.2 | ... | ... | ... |
| 10.47 | ... | ... | 18.9 | ... | ... | ... |
| *P.M.* | | | | | | |
| 1.28 | ... | ... | 18.4 | ... | ... | ... |
| 2.07–2.09 | ... | 0.072 | ... | 95 | 9.5 | 10.0 |
| 2.14–2.16 | ... | 0.072 | ... | 96 | 9.5 | 10.0 |
| 2.30 | ... | .... | 18.2 | ... | ... | ... |
| 3.52–3.55 | ... | 0.072 | ... | 109 | 7.5 | 9.5 |
| 4.00–4.02 | ... | 0.072 | ... | 110 | 7.0 | 9.5 |
| 4.52 | ... | ... | 18.0 | ... | ... | ... |
| 5.20–5.22 | ... | 0.072 | ... | 120 | 3.0 | 8.0 |
| 5.27–5.29 | ... | 0.072 | ... | 121 | 3.0 | 7.5 |

[1] Magnet turned on. [2] Magnet circuit reduced to 10 amperes and left for night.
[3] Magnetic field muscle continued to show threshold at 6 until 9.40 when it became impossible to obtain contraction even with maximum stimuli. Electrodes on both nerves were accordingly moved into the positions indicated in 2c. Both nerves were slowly drying in spite of moist chamber conditions.

previous experiment and were compelled to contract repeatedly, lifting each time a 70-gram weight and registering their work through two similar work-adders. In this particular instance the belly of the muscle subjected to the magnetic field was placed immediately above the pole tips C and D and the magnet was held at 20 amperes. The muscle, therefore, was subjected to a field intensity of approximately 17,950 c.g.s. lines per square centimeter (Table 2). In this experiment the tracings written by the control C and the magnetic field muscle M are practically identical, the work done by the control being 2,856 gm. cm., and by the magnetic field preparation 2,639 gm.

cm. Such results fall within the limits of error in comparisons of two normal muscles and indicate no harmful effect from the magnet. The same experiment repeated ten times never gave evidence of any action whatsoever on the part of the magnetic field.

Figure 5 displays fatigue curves made by two companion isolated muscle preparations stimulated directly, the electrodes in each case being placed in the capsule of the knee-joint and in the gastrocnemius tendon. During the period of work muscle M was subjected to a magnetic field of approximately 17,950 c.g.s. lines per square centimeter, the belly of the muscle lying just above the tips of the poles C and D. In this case the control muscle C did 3,444 gm. cm. of work against 3,668 gm. cm. for the muscle exposed to the magnetic field.

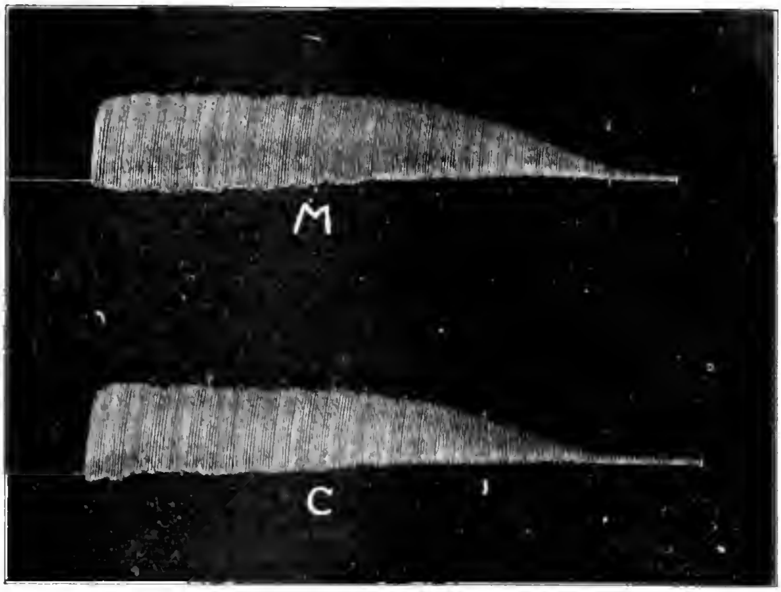


Fig. 5. — Fatigue curves written by companion gastrocnemii muscles under identical conditions of stimulation. C indicates control muscle; M, muscle exposed to magnetic field.

Omitting details of other experiments, we may sum up our results by saying that in isolated nerve-muscle preparations we have never been able to observe any change in irritability or conductivity of nerve nor in the contractile power of muscle as a result of exposure to the magnetic field.

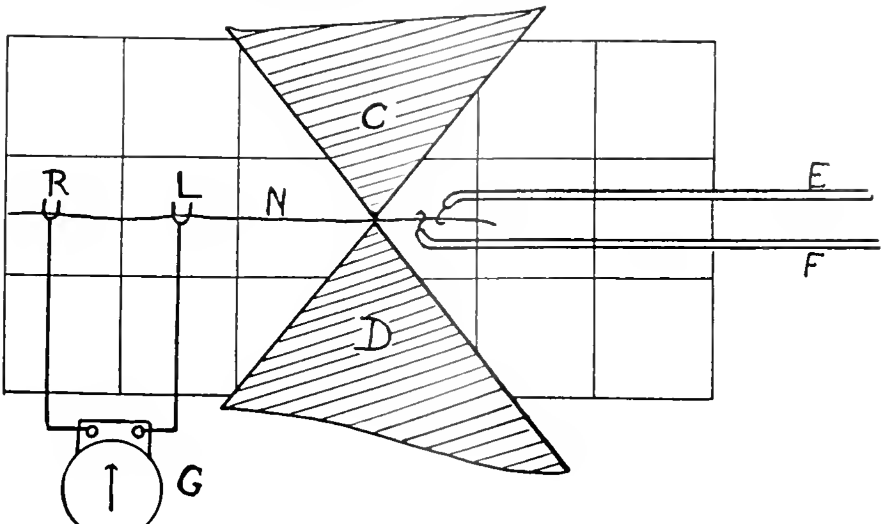


Fig. 6. — Diagram of apparatus for recording the action current of mammalian nerve. E and F indicate stimulating electrodes; C and D, pole pieces of magnet; L and R, non-polarizable electrodes leading to the string galvanometer G.

As a final experiment to test the effect of the field upon the nerve impulse we placed a long section of cat nerve (popliteal) in a moist chamber under the conditions given in the diagram, Figure 6, in which E and F are the stimulating electrodes and L and R leading off electrodes to a string galvanometer.* Figure 7a is a photographic record of the action current of this nerve prior to magnetic field exposure, and Figure 7b a record of its action current after two and one-half hours' exposure to a field of 18,725 c.g.s. lines per square centimeter. As this record shows, the magnetic field produced no change in the action current which signals the passing of the nerve impulse.

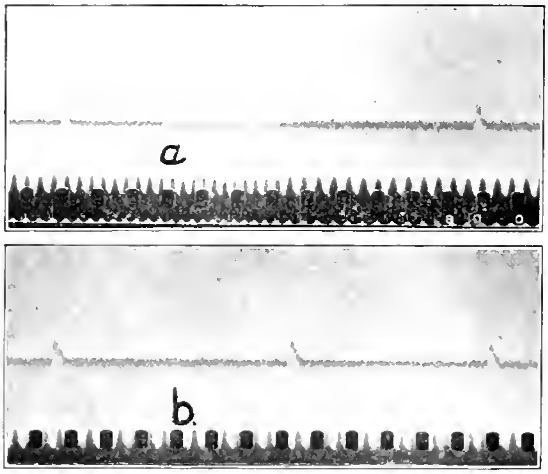


Fig. 7a. — Action current of popliteal nerves prior to exposure to magnetic field.
b. — Action current of same nerve after two and one-half hours of exposure to a field of 18,725 c.g.s. lines per square centimeter.

In addition to these experiments with isolated nerve and muscle, a certain number of experiments were done with red blood corpuscles and blood. It was shown that prolonged exposure (two and one-half hours) to magnetic fields of 18,725 to 14,200 c.g.s. lines per square centimeter had no effect upon the shape of red blood corpuscles nor upon their oxygen combining power. In the same strengths and conditions of exposure complement and hemolytic amboceptors were likewise unaffected.†

*e. Experiments upon Animals.* — The exposure of living animals to magnetic fields for short periods of time and under a considerable degree of restraint is easily arranged, but, feeling that such a procedure gave little promise of interpretable results, we endeavored to find small animals of active type — certain to make natural movements in the field — and to expose them under circumstances permitting constant observation of their condition. Dancing mice were finally selected as the mammal most suitable for the experiment.

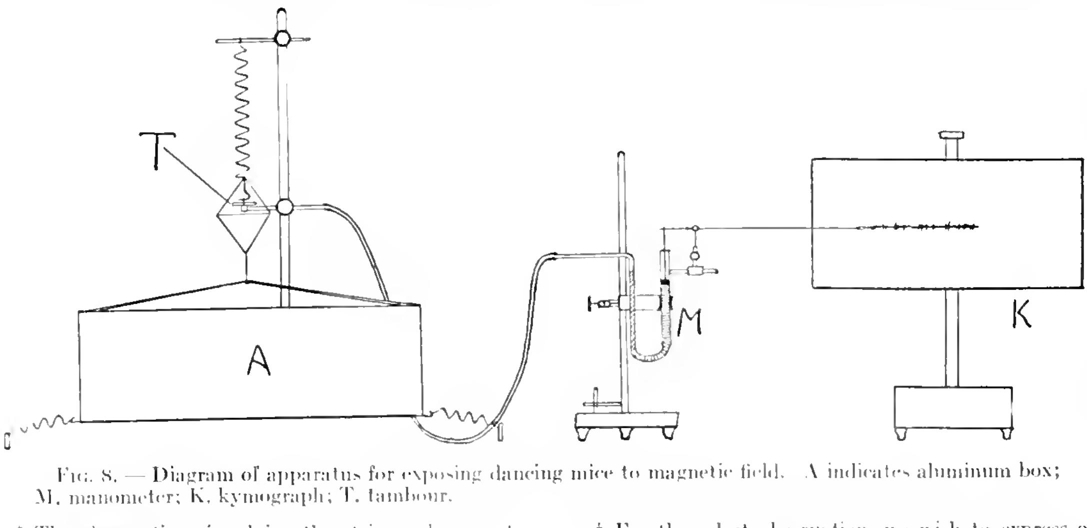


Fig. 8. — Diagram of apparatus for exposing dancing mice to magnetic field. A indicates aluminum box; M, manometer; K, kymograph; T, tambour.

* The observations involving the string galvanometer were made for us by Dr. Alexander Forbes.

† For these last observations we wish to express our thanks to Dr. A. Watson Sellards.

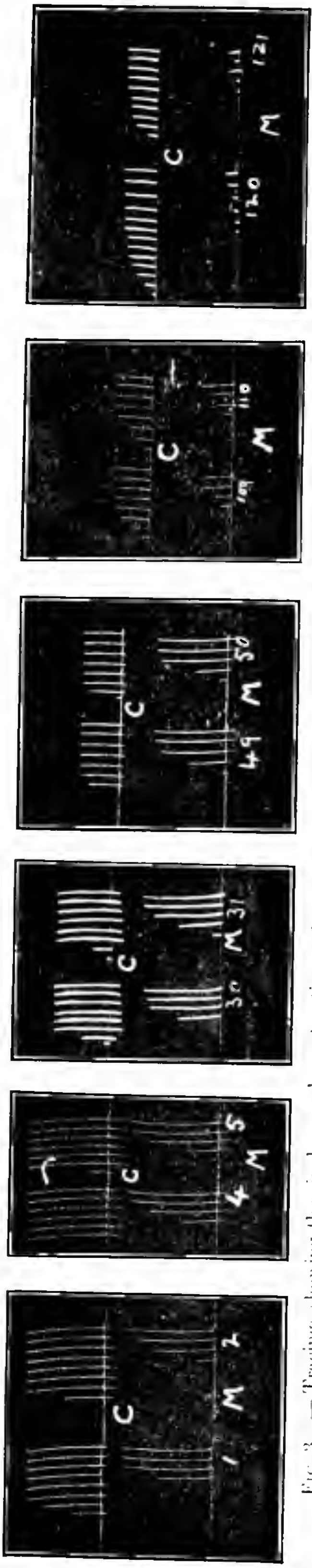


FIG. 3. — Tracings showing the single muscle contractions of two gastrocnemii under identical conditions of stimulation, except that the lower muscle was contracting in a strong magnetic field.

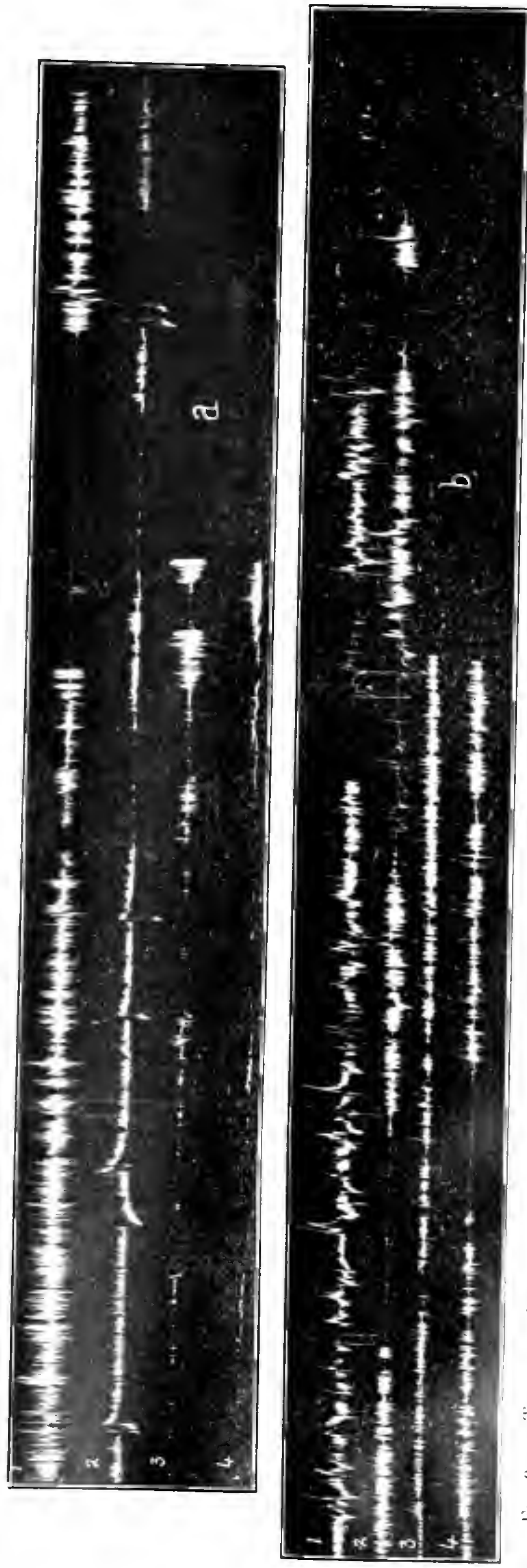


FIG. 9a. Tracings indicating the activities of two pairs of mice placed in aluminum boxes such as the one diagrammed in Figure 8.
b. Tracings from the same animals three months later; 3 is the day record for the mice exposed to the magnetic field, and 4 the night record for the same pair.

These animals are small, active, and easily cared for during a protracted experiment. Accordingly, we exposed dancing mice in pairs to magnetic fields, the strengths of which are given in Table 3.

Figure 8 indicates the manner in which these animals were studied. An aluminum box A, 6 by 12 inches, served as a cage for a pair of mice. This box was suspended by a light brass spring adjusted to a tambour T so that every movement of A acted upon the rubber diaphragm in T and by air transmission activated the oil manometer M which wrote upon a slowly moving kymograph K. The box A was lightly anchored at the corners by brass springs and fitted into the large gap in the magnet, secured by removing pole pieces C and D. A control pair of mice occupied a second box, their movements being recorded upon the same kymograph through exactly similar devices. Mice lived in the box A for periods of three months, being exposed to fields of approximately 2,800 c.g.s. lines per square centimeter for an average of fifteen hours daily during this period. The magnet was turned on when we left work in the evening and turned off next morning in order to avoid the annoyance of having it active during working hours in the laboratory. The life of the mice during periods of this sort was apparently entirely normal. Females became pregnant, and when killed near term were found to contain normal young. No signs of disease were observed. The mice continued sound during the experiment and their organs, when examined microscopically at the close of the experiments, were found to be normal.

In Figure 9a we have a record covering a twenty-four-hour day for the control pair of mice and for the pair exposed to the magnetic field. The two lower lines of tracing represent the movements of the pairs of animals in their cages during the day period, and the two upper longer lines, the activity during the night. Figure 9b shows a similar set of tracings upon the same pairs of mice after three months' exposure of one pair to the magnetic field. The top and third from the top tracings are those for the magnetic field mice and show a normal degree of activity.

As a final type of experiment we frequently placed our own heads in magnetic fields of as great strengths as were obtainable, but were never able to appreciate any effect whatsoever — a result which corroborates the findings of Peterson and Kennelly (4). With the magnet which we used the effects of alternating currents could not be tested, and we are, therefore, not in a position to speak upon this phase of the subject.

## Conclusions

1. The effect of constant magnetic fields varying between 18,725 and 2,800 c.g.s. lines per square centimeter has been studied in experiments upon various types of nervous and muscular tissue, upon blood, and upon intact animals.

2. None of these experiments has given the slightest evidence of physiological effects from the magnetic field.

3. The experiments cited have utilized field strengths far greater than those to which workmen are subjected, and, since the tissues employed were those most likely to show vulnerability, it seems certain that the magnetic field has no significance as a health hazard.

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# THE INDUSTRIAL PHYSICIAN AND THE QUALIFICATIONS ESSENTIAL TO HIS SUCCESS *

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OF all the specialties in the medical field, perhaps the one which is least understood is that of the industrial physician. To emphasize the importance of this specialty, we have but to recall some instances of the past. We are more or less familiar with the disastrous effect, during the war, of the manufacture of the explosive, trinitrotoluene, resulting in fatal cases of toxic jaundice, as described in the report of the Ministry of Munitions, London. Previously, this substance had hardly been regarded as toxic; but when the necessity arose to manufacture it in large quantities, and at a time when the conservation of the life and health of the worker was of the utmost import, mortality from its poisonous effects became alarming. Had it not been for the preventive measures instituted by a few men with training in the hazards of industry, based on previous knowledge and experience of the nearest analogies, the mortality from this poisoning would have been markedly increased; and had this branch of medicine been developed equally with other specialties, one is justified in believing that the mortality not only from T.N.T. poisoning but from the large list of other recognizable hazards would have been appreciably lowered.

The trend of modern thought is toward conserving and preserving human life. Science functions at its best when it conquers disease and reduces the hazards of human existence. Industrial hygiene shares its place with other welfare organizations designed to give the youth of the nation a chance to develop mentally and physically, to keep the body strong and well and fitted for the tasks and duties of the day, and to live long and useful lives. Millions of dollars are spent, and justly so, in the control and prevention of disease, in providing pure drinking water and food products from healthy stock, and in educating the public in health matters. Yet, little indeed is to be gained by these activities and by the expending of additional enormous sums of money in the rearing and education of children, and in the promotion of their health, if their lives, at the prime, are only to be crushed out by the unnecessary hazards of industry.

Oliver (1) speaks of lads under 18 years of age who were given employment where the lead hazard existed. "These youths," he says, "all of good physique, well-developed and healthy looking, were examined medically before entering the factory, and yet, notwithstanding this precaution, so great was the amount of lead poisoning amongst them, and in such a short time, too, that the employers were obliged to dismiss them." In recent years, however, much has been accomplished, both in foreign countries and in America, toward eliminating this hazard which is perhaps the greatest of all industrial hazards, and which at one time was present in about 150 different industries. But the hazards with which the industrial physician must cope are still many and require constant vigilance.

Throughout every state and virtually every community in this country costly machinery is installed and maintained at a high degree of efficiency, for the purpose of increasing production. Aside from purely humanitarian views, if we conceive of the workman as a factor in production, we are

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in him dealing with the most potentially efficient machine in the universe.

M. Amar (2) describes the human motor as probably an "electro-capillary" engine, the nature of the nervous agent and the origin of human power being, however, unknown. Man's power is approximately 1–7 H.P., but the efficiency is about 30 per cent., or very high. Compared to a steam engine, the human motor performs its work on half the fuel consumption. The life of the human motor is greater than that of any inanimate prime mover, which is placed at a maximum of 20 years unless frequently repaired. Till old age sets in, the human motor is self-repairing. Its control is internal. In general:

"The maintenance of the human machine is as difficult and important a matter as the maintenance of any inorganic motor. We must do our best to eliminate all internal and external conditions tending to cause depreciation. Especially must physiological discomfort be avoided and removed, as far as possible. In the due proportion of effort and speed, in industrial labor, lies the key to intensive production and the well-being of the workman."

The uninitiated may marvel that a science should exist for the purpose of increasing human efficiency and decreasing waste; yet it is only by the application of the scientific principles of industrial hygiene and sanitation that a man can produce an increased yield sufficient to justify a larger compensation for his labor, and can thus be enabled to live in comfort and to find new strength and enjoyment in his work each day. It is, therefore, of vital import that the public at large should be interested in those conditions which materially affect the health and welfare of approximately one-third of the population of enlightened countries — namely, the producers of the world. To accomplish constructive improvements, organization of interests and co-operation with other sciences are essential; but as the human factor, with which the physician has to deal, is the greatest of all factors in the activities of life, all other factors should revolve around it as a center.

Unfortunately, the term "industrial physician" has been erroneously applied to general practitioners who spend part time in treating cases of sickness and injury sent to them from industrial plants. Even contract physicians have been at times classified under the same head. The restricted conception of the industrial physician limits the appellation to the man who has specialized in the field indicated in this paper. He is no longer the practising physician who makes an hourly trip to the plant in order to dress minor injuries, or who is called when a worker suddenly becomes ill or is hurt. On the contrary, he is a trained specialist in industrial hygiene and occupational diseases, and does not engage in the general practice of medicine nor of surgery any more than does the specialist in other branches of medicine.

It is true that little opportunity is offered the industrial physician to prepare for his specialty, and he must of necessity accumulate his knowledge from promiscuous sources. An attempt has been made to merge this all-important specialty, as a branch, with preventive medicine or social medicine, but the field of industrial hygiene and sanitation is sufficiently broad and sufficiently well defined to constitute in itself a specialty, and the demand for trained men is imperative. A few medical schools are now recognizing the importance of training men for this work and are offering special courses for it. Much remains to be accomplished in this direction, however, and a more comprehensive course including actual field work is desirable.

Diagnosis of ordinary occupational diseases is, to be sure, not difficult, but early recognition of them, which is all important, is quite so. It is unfortunate that the industrial physician must for the most part recognize the early diagnostic symptoms of many industrial diseases through experience and from the perusal of special articles, for the reason that textbooks usually emphasize only the more advanced symptoms. It is obvious, therefore, that

to become qualified for his task, the industrial physician must have special training and special qualifications as well.

In the first place, the question arises as to the specific position of the industrial physician in industry — whether he serves the employees or those who employ him. The physician who serves either to the exclusion of the other fails in the high purpose of his mission. I know of physicians who are employed mainly for the protection of the management against lawsuits, and who are expected, no matter what the cause of the ailment or injury, to convince the patient that his trouble is the result of his own carelessness and is in no way caused by his working conditions. Such policies among physicians are soon recognized by employees, and have a tendency to cause them to resent, and with some degree of right, the aid offered them by fair and conscientious physicians.

The task of the industrial physician is by no means easy. He occupies the position of *liaison*, as it were, between management and employees. His duties toward the former are to increase the efficiency of the workers, in order to secure and maintain a high rate of production; to prevent wastage; to minimize labor turnover; and to interpret the workers to the management, by pointing out causes of dissatisfaction among them and suggesting remedies for it. His duties toward the employees are to promote health, sanitation, personal hygiene, and contentment; to maintain cleanliness and order; to lessen the possibility of accidents and disease; to protect against dust, industrial poisons, inadequate ventilation and illumination, over-fatigue, draught, extremes of heat and cold, danger of fire; to advise in the selection of jobs suitable to the physical capacity of individuals; to improve the morale; and to interpret the management to the workers.

In order to accomplish these ends, the industrial physician should be characterized first of all by fairness, tactfulness, and a sympathetic attitude, which will enable him to secure effective co-operation. He must evaluate statements of both employer and employed; must discriminate between facts, opinions, bias, and prejudice, through observation of actual conditions; and wherever possible must base his judgment upon facts instead of upon opinions.

In making the initial physical examination of the worker, the physician should be guided by the mental as well as the physical fitness of the individual, and should assist the management in hiring advantageously and in giving each new man such work as he can best perform. When we consider the fact that, as measured by mentality tests, the greater number of men in the army were of average or less than average intelligence — which is probably true today of the men of the country as a whole — it is evident that, in spite of some limitations, each man according to his grade of mentality and intelligence may be assigned a part in the whole organization that will lead to his success and happiness.

Again, the ability of the industrial physician and his value to industry are measured largely by his knowledge of and familiarity with the needs of the plant. Before he can recommend or even suggest changes for improvement, he must have at least a working knowledge of the materials used, the products and by-products manufactured, the processes involved, and the possible hazards existing.

The industrial physician's first duty on assignment to any plant is to make a comprehensive survey of conditions, including an analysis of each department into its various jobs and a study of the processes of each. The paramount idea of such a survey is "seeing with trained eyes" and utilizing the collected facts to establish a basis for recommendations. No alteration or improvement should be recommended without sufficient reason, and the physician

should guard against staggering the management with recommendations requiring large expenditures of money. A survey likewise fails if the investigator is unable to interpret his findings.

It may be well to review briefly the most important factors which may constitute hazards in industry and which are of interest to the industrial physician. Let us first consider the subject of ventilation. While the task of providing adequate ventilation in the larger plants is the duty of a ventilating engineer, the maintenance of the ventilation system and, in some instances, the installation of the system rest upon the industrial physician. The essential factors to be considered in ventilation are temperature, degree of moisture, and air movement. The air may be vitiated by impurities which arise from manufacturing processes, from floors of the rooms, from persons, from lights burning, and from accidental sources, such as effluvia from drains, escape of gas, or impure outside air. The industrial physician should know the composition of pure air, and its value. He should be familiar with methods of removing impurities, pollution, dust, and dampness of surrounding surfaces, and should see that there is sufficient cubic capacity, with absence of overcrowding, constant movement of the air, proper and rightly placed inlets and outlets for the air, cross-ventilation, and moderate temperature and humidity. The objectionable features of an inadequately ventilated room are more frequently thermal than chemical.

No less important is the problem of adequate illumination, and a thorough knowledge of the subject is particularly essential for the successful industrial physician. With proper illumination over the working areas, the safety and skill of the worker may be maintained at a high standard, and production increased in quantity and improved in quality. Distinction must be drawn in regard to illumination, surface brightness, and glare. The physician should not only be familiar with the unit of measure for general illumination and the methods employed to test it, but should also know the number of units necessary for the performance of different kinds of work. The effectiveness of illumination cannot always be measured in terms of the vertically downward component of the light as it is sometimes of advantage to light the work plane from the side. For larger plants, at least, the engineer should be consulted in order that the fundamental principles of effective illumination — sufficiency, continuity, and diffusion — may be fulfilled.

The problem of illumination is by no means solved simply by the installation of an efficient system. Indeed, the maintenance of the system is of equal importance, because frequently, through neglect of proper upkeep, one-half of the light which a system is capable of supplying may be lost to the worker. The change from sufficient to insufficient light is very gradual and is often overlooked. Dust and dirt accumulate slowly, reflectors break, ceilings become darkened by degrees, here and there is an empty socket or a lamp of incorrect voltage. Thus, it frequently happens that the cumulative effect of these needed repairs is noticed only after the workmen complain of eyestrain.

The proper method of using lighting equipment so that it may be suitable to the needs of a plant is as important as the wise choice of a system. Whether direct, indirect, or semi-indirect light is best, depends upon the purpose for which the light is to be used. It should also be remembered that faulty reflectors may do more harm than none at all.

That certain occupations are more fatiguing than others is common knowledge, and the physician is not interested in fatigue in the ordinary acceptation of the term; but he is deeply concerned with the effects

produced by over-fatigue, the boundary line between fatigue and over-fatigue, and the length of time necessary to recover from fatigue. There is no uniform method of treating this problem, and the physician must work it out to the best of his ability for each individual industry, for both sexes, and for different climates. Other problems, with which he is concerned and for which he should bear the responsibility, are personal service facilities, rest periods, welfare work, and effective methods of cleaning the plant.

As an aid in predicting the effects of certain reactions upon the worker, a knowledge of chemistry is of great advantage to the industrial physician, particularly as the substances used in industry are many and varied, and their effects multiple. For instance, it is an interesting fact that there are about 300 substances used in industry, which cause skin diseases and in dealing with which a knowledge of chemistry would clearly be exceedingly valuable.

Too much stress cannot be placed upon the importance of careful records. While it cannot be expected that every industrial physician should be a statistician, he should at least understand the fundamental principles of statistics, and if, in addition, he possesses the ability to interpret them accurately, it is a distinct asset to him. For record keeping, he should employ a standard form in general use, such as that suggested by the U. S. Public Health Service.

In conclusion, I wish to emphasize the value of the industrial physician in the mitigation of industrial unrest, which in large part is the reaction to unfavorable environment. Insanitary working conditions lower physical resistance; monotonous labor, discontentment, and continued long hours increase those physical defects which are soon acquired when resistance is lowered, and in turn the worker who has lost his former strength and vigor must accept lower wages, and poverty, with its many evils, is the result.

Diminished output is a danger sign of diminished physical energy. Desire to work cannot exist without good health. A healthy and contented laboring force is the greatest economic asset that capital can have, and such a force should be so protected and so guided that the greatest possible benefits may accrue to both employer and employee.

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# AN INTERCHANGE OF PHYSICAL EXAMINATIONS IN INDUSTRY*

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A GREAT deal has been written concerning the many advantages of the compulsory physical examination in industry, but only once in a while is anything written — and then but a line or two — in regard to the objections that are advanced by the employer or the employee. The objections given by the employer are usually concerned with the cost of the service, while those of the employee are based upon some personal reason, such as his natural dislike for anything which he feels is being forced upon him and which may in some way abuse his private rights, or for any procedure which entails extra bother. Or perchance, as I have frequently known to be the case, he may object on the ground that he has recently been examined by a good doctor who said that he was all right, and therefore he does not care to be examined again.

We can oftentimes learn something from the other fellow even though his training may lead us to believe that he really has no right to an opinion on the subject in question, and I think that on the subject of compulsory physical examination, if we care to, we can undoubtedly learn something from our applicants. While for the most part compulsory physical examination is basically right, there are some respects in which it may be basically wrong, and it is on this side of the question that I wish to sermonize a little.

When an order is issued in an organization it is exactly comparable to an order in the regular army — it must be carried out, right or wrong. When it is ordered, however, that "Every man must have a complete physical examination before he can be given a job," the order is so general and so broad that it may easily include some things that are not right, and which give rise to unfortunate conditions, as I have witnessed many times during the past two years. Indeed, who has not seen this particular incident occur time without mention: A great big fellow — the picture of health — who has recently been pronounced physically fit by a regular army officer or some industrial physician, applies for work. By reason of an order in the organization, the doctor must make a complete physical examination before the applicant can be accepted. Under these circumstances two unfavorable things often happen. First, the doctor feels in his own mind that the man is normal and that he most certainly needs no complete examination, and the result is that the work is often carelessly done and time is consumed that costs the company money without bringing any returns. Second, the applicant himself feels that he does not need a complete examination, and consequently the procedure appeals to him as a mockery, with the result that he is annoyed and has a lower regard for medicine in industry.

In order that the many advantages of the physical examination may be conserved, we should now concern ourselves with improving its *modus operandi* by ironing out wrinkles wherever possible. In this connection, why should institutions which require physical examinations not adopt the policy of giving an applicant a card showing his physical condition? Within a limited time, this card plus an examination for acute diseases should be accepted in

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lien of another *complete* physical examination. These cards could easily be standardized and interchanged between any shops carrying on good medical work.

I can see several excellent results from such a system. First, it would rule out many of the normal cases that require no complete physical examination, and would thereby render two distinct benefits — the doctor's work would become less monotonous, and much time would be saved. I believe that many of the industrial physical examinations have degenerated into a monotonous routine. Indeed, I know of nothing more uninteresting to an intelligent doctor than an examination of numerous normal cases. The time saved could be spent to most excellent advantage in discussing personal or organization affairs, shop conditions or other subjects which aid in determining the employees' ideas of life and industry, and help so much in establishing pleasant personal relations between the dispensary and the plant. Second, I think that the importance and use of the physical examination would appeal much more strongly to the applicant if some written statement accompanied it. It would help make the intangible benefits of the examination more tangible. Do you not think that almost any man would regard with considerable pride a card stating that he was in sound physical condition, or can you not easily imagine that the written card might help impress upon the applicant the seriousness of some existing defects? Might it not lend a personal touch that would help us immensely in selling medical ideas to employees?

# PHYSIOLOGICAL EFFECTS OF AUTOMOBILE EXHAUST GAS AND STANDARDS OF VENTILATION FOR BRIEF EXPOSURES

*Continued*

YANDELL HENDERSON, HOWARD W. HAGGARD, MERWYN C. TEAGUE, ALEXANDER L. PRINCE, AND RUTH M. WUNDERLICH

## IV. Concordance of the Standard here Proposed with the Observations of Other Investigators

THE standard defined in Figure 4* may seem, from the work of others, especially that of Haldane, unduly high, if one fixes attention upon the concentration of carbon monoxide in the air breathed: or it may appear unnecessarily low, if stated in terms of the maximum percentage saturation — *i. e.*, complete equilibrium of the blood and the corresponding tension. The work of Haldane is so pre-eminent in this field, alike in amount, thoroughness, and practicality, that discordance between the conclusions drawn from his investigations and the standard here proposed would require elaborate explanation and defence. In fact, however, we believe that when all aspects, of the question are taken into consideration our observations and conclusions, although differing in detail, are essentially concordant with those of Haldane (4) (5). Briefly stated, his principal conclusions were as follows:

The symptoms caused by carbon monoxide depend upon the extent to which the hemoglobin has been saturated. The symptoms are due solely to the deficiency of the oxygen percentage in the blood.

When air containing carbon monoxide is breathed, about half of the carbon monoxide actually inhaled is absorbed, except toward the end of the process when absorption is coming to a standstill.

The rate of absorption and time required for symptoms to appear is proportional to the respiratory exchange and may be very much shortened by the increased breathing of exercise.

The symptoms do not become appreciable during rest until the blood is about a third saturated. An individual in this condition suffers from palpitation and throbbing in the head and is liable to become faint or dizzy on any exertion, such as that of ascending a stair, or on sudden exposure to cold air.

In experiments on himself Haldane (6) found that, when 50 per cent. saturated, he could scarcely stand and could not walk alone without falling down. There was giddiness, dullness of the senses, distinct shortness of breath, and labored breathing. In the course of two or three hours after leaving the contaminated air he found that nearly all the carbon monoxide disappeared from the blood, which had then returned to its normal condition. A headache lasting for some hours was likely to ensue from the exposure if the latter were sufficiently long.

In reporting on the conditions which should be maintained in the Underground Metropolitan Railways of London (7), he said:

> Roughly speaking, the probable action on a healthy person of varying percentages of carbon monoxide in the air may be stated as follows: 2.5 volumes per 10,000 would suffice after a sufficient time (after an hour and a half during rest, but very much less during even slight exertion) to cause symptoms just distinctly appreciable on exertion. Five volumes per 10,000 would cause marked dizziness or fainting on exertion, 9 volumes would cause in-

* For figures, see the first part of this article in the preceding issue of the Journal of Industrial Hygiene.

ability to walk, and about 15 volumes might produce death. . . . Considering the enormous number of people in various states of health who use the railway, . . . it seems desirable that not more than one volume per 10,000 of this gas should be present in the air.

To these statements may be added the fact that Burrell (8) found that after breathing air containing twenty-five parts of carbon monoxide per 10,000 of air for twenty minutes he had at first only a slight headache, but later became ill. The illness lasted for several hours and was accompanied by nausea and headache.

The agreement of these statements with our conclusions is sufficiently close to need no further discussion, until the question of the allowable concentration of carbon monoxide — a concentration producing no appreciable effects in any one — is reached. On this point Haldane recommended one part in 10,000, while we approve concentrations up to four parts, or, with longitudinal ventilation, even six. It is to be noted, however, that the conditions to which Haldane's recommendations applied were in some respects different from those which will occur in a vehicular tunnel. The motive power in the London Underground Railways was at that time (1897) furnished by steam engines burning coke. The engine drivers and train crews and even some passengers might be exposed for considerable periods of time — much longer than we have figured on. Haldane seems to have had in mind the possibility that exposure might be so long that the blood would come nearly into equilibrium with the tension of carbon monoxide in the air breathed and reach a corresponding percentage of saturation. We, on the contrary, are basing our estimates on times of exposure too short for the attainment of more than half the equilibrium degree of saturation.

The apparent discrepancy between the two standards lies in the figures for the concentration of carbon monoxide in the air breathed. If, however, we turn to the more fundamental physiological condition — namely, that of the percentage saturation of the blood — the discrepancy largely disappears. Thus, a glance at Figure 4 shows that thirty-five minutes in an atmosphere containing four parts of carbon monoxide in 10,000 could induce 12 per cent. blood saturation. Now blood which is 12 per cent. saturated is in equilibrium with one part of carbon monoxide in 10,000 of air. In other words, a stay of several hours in an atmosphere of one part of carbon monoxide in 10,000 would involve the same percentage saturation as a stay of thirty-five minutes in four parts per 10,000. Indeed, as the development of symptoms from carbon monoxide is wholly a question of oxygen deprivation, it is safe to assert that a saturation of the blood up to 16 per cent. lasting for only a short period would involve less physiological effect than a prolonged period of saturation at 12 per cent.

On these grounds we have indicated in Figure 4 two standards: (1) for the blood at 12 per cent. saturation, or one to 10,000 tension, for exposures of some hours; and (2) at 16 per cent. saturation, or 1.5 to 10,000 tension, for brief exposures. The whole matter may be even more simply summed up in a single expression involving the time measured in hours, the concentration of carbon monoxide in the air in parts in 10,000, and a constant for each degree of physiological effect. The physiological effects of all concentrations and times (within reasonable limits) may be then defined as follows:

1. Time × concentration = 3, no perceptible effect.
2. Time × " = 6, a just perceptible effect.
3. Time × " = 9, headache and nausea.
4. Time × " = 15, dangerous.

Physical exertion and increased breathing would reduce the constant in the first

equation from 3 to 2, 1, or even less, and would affect the other equations correspondingly. Any standard for any special conditions of time or concentration, within reasonable limits, based on these formulae, is sufficiently concordant both with the recommendations of Haldane and with the summary of our observations and conclusions contained in Figure 4.

Finally, we may here quote from a letter recently received from Dr. Haldane, which was in answer to a letter from us stating the general trend of our observations and findings and in which Dr. Haldane says:

> In the report on the Underground Railway the chemical standard which I recommended if steam traction was continued was .15 per cent. of carbon dioxide, and I pointed out that this would contain about .01 per cent. carbon monoxide. But the standard was not based primarily on the carbon monoxide, but on the general unpleasantness of the air. There was no definite evidence of people being upset by the carbon monoxide, though there was often .03 to .05 per cent. at certain parts of the tunnels and stations; and I even found .066 per cent. of carbon monoxide (with .89 per cent. of carbon dioxide) on the platform of Gower Street Station (near University College). Passengers were never exposed long enough for ill effect, and the men at the stations were probably more or less acclimatised.
>
> At that time I did not know nearly so much about small percentages of carbon monoxide as I do now. Lorrain Smith and I made a lot of experiments on ourselves(to determine oxygen tension of arterial blood) (Jour. Physiol., XX, 1896, and XXII, 1897) and came to the conclusion that anything less than .06 per cent. produced no symptoms after several hours' exposure except some shortness of breath on exertion. Our blood saturations only went to about 28 per cent. (in about one and one-half hours), and no further absorption occurred up to five hours. About a year later we tried a similar experiment and found .06 per cent. far too much for us. I tried again at Oxford later, and now found that even with about .03 per cent. the saturation gradually crept up during four or five hours to over 30 per cent. It became clear afterwards that in the first experiments we had both got acclimatised and were thus abnormally resistant to carbon monoxide.
>
> What I should now say is that with long exposures of several hours anything more than .02 per cent. should be avoided. For exposures of less than an hour .05 per cent. would not be really objectionable. As regards gases from motors, however, the smoke and smell might possibly be worse than the carbon monoxide. On this point I have no experience, though I have run across cases of poisoning where there does not seem to have been much smoke or smell.
>
> You will see from the above that my ideas about carbon monoxide coincide very closely with what your experiments point to. Lorrain Smith and I had not the least idea that by our daily experiments we had become acclimatised and ready to secrete oxygen as soon as our blood saturation rose to about 25 per cent. The absorption was simply stopped short as soon as oxygen secretion began; but an ordinary person does not secrete at this level, so the absorption goes creeping up for hours.

## V. Observations in Large Gassing Chamber

The experiments detailed in Section II involve exact, but rather artificial conditions. Exhaust gas is not pure carbon monoxide and the number of persons who could be tested in the 6 cubic meter chamber was quite limited. It appeared essential, therefore, to obtain confirmatory observations under as nearly real conditions and on as many persons as possible. For this purpose a brick building, 30 feet square, with walls 12 feet high at the side, and a hip roof, was erected. Its cubic capacity was approximately 12,000 cubic feet of air, which is about the volume of a section of the vehicular tunnel which will contain one car when the traffic is active.

A Ford car was installed near the middle of this chamber, with a continuous stream of water running into and out of its radiator to prevent over-heating. The axles were supported on a wooden framework so that the rear wheels turned clear of the ground. Against them were pressed two large wooden pulley wheels on a piece of heavy shafting, at the ends of which were wooden paddle wheels. The engine of the car, therefore, ran with a fair load, and the power was expended in mixing the air in the chamber. The paddle wheels did this so

effectively that in a number of tests practically uniform concentrations of exhaust gas were found simultaneously in all parts of the chamber.

The exhaust of the car was connected to a 2-inch iron pipe with a T and two valves. From one valve a pipe led to a large iron can (to equalize pressure) and to a gas meter, and discharged close to one of the paddle wheels, which drew in and distributed the gas. The pipe from the other valve led outside of the building. Thus, by adjusting the valves, all or any part of the exhaust gas could be discharged into the chamber, and its volume read on the meter. Samples of the exhaust gas unmixed with air were taken and analyzed for carbon monoxide in an Orsat apparatus, using ammoniacal cuprous chloride as the absorbent. The percentage ranged between 5.5 and 6.8 per cent., with an average of about 6 per cent. The engine discharged a total of about 25 cubic feet of exhaust gas per minute, from which we calculated that approximately 1.5 cubic feet of carbon monoxide were produced by the car per minute.

Diffusion from the chamber through the walls and roof, and through cracks around the doors and windows, was considerable. Whenever the engine was stopped, there was thus a drop of about one-third of the concentration of carbon monoxide in fifteen minutes. Usually the entire exhaust of the engine was discharged through the meter into the chamber until the desired concentration of carbon monoxide was approximately reached. Thereafter, a part of the gas was discharged out of doors, and only enough was passed into the chamber through the meter to compensate for loss by diffusion. Samples of the air in the chamber were taken at intervals during the period of exposure, and the amount of carbon monoxide determined either by means of iodine pentoxide (with a correction for vaporized gasoline), or by the blood carmine method, or in both ways. Some discrepancies will be found in the analytical data, but it must be kept in mind that the methods are difficult and the amounts of the substance are minute far beyond the range of ordinary gas analysis.

With practice, considerable facility in controlling the concentration of carbon monoxide in the chamber was attained. The experimental conditions were quite realistic. The car was old and had had rough treatment, and the engine was somewhat irregular in action. The exhaust gas was, therefore, contaminated with at least as much gasoline, oil and soot, and other substances, in addition to water vapor, carbon monoxide and carbon dioxide, as may be met with in any well-regulated vehicular tunnel. Owing to the fact that vaporized gasoline and other constituents of exhaust gas beside carbon monoxide act upon iodine pentoxide, the figure 0.6 was determined as the factor by which it was necessary to multiply the iodine liberated in analysis of chamber air for the estimation of the carbon monoxide.

In this chamber groups of a dozen or more persons at a time sat or moved about for periods of one hour. In addition to the staff of this investigation a number of students of the Yale Medical School served as subjects. We take this opportunity to recognize the intelligent interest manifested, and the valuable service rendered by these young men and women.

After the tests the general condition and feelings of the subjects, particularly the occurrence or absence of headache, were noted. When the subjects had breathed fresh air for five minutes after leaving the chamber, samples of lung air, obtained by having them rebreathe repeatedly into a small rubber bag, were analyzed for carbon monoxide. In such analyses the gas found is that which has diffused out of the blood into the lung air, and the analytical data indicate, therefore, the tension of the car-

bon monoxide in the blood. The effect of running up and down four flights of stairs was also noted, as exercise markedly intensifies asphyxial symptoms.

Only a few typical protocols of these tests can be given in this abbreviation of our report, but the whole of the data may be summarized by the statement that, so long as the standard worked out in the previous section was not exceeded, no appreciable ill effects were induced in any of the numerous subjects. Above this standard, however, headache resulted in nearly all cases, and in some persons nausea and vomiting also occurred.

### *Details of Observations in Tunnel Gassing Chamber*

Protocol 1. — Feb. 4, 1920. The engine of the car was started and maintained at a uniform speed for twenty minutes. Determinations were made of the carbon monoxide percentage in the exhaust from the engine (analyzed with Orsat apparatus), and of the concentration of the gas in various parts of the chamber (by the iodine pentoxide method). For the latter purpose, two positions were chosen: No. 1, 6 feet to the west of the exhaust; and No. 2, 9 feet to the north of the exhaust.

TABLE 3. — EXPERIMENTAL CONDITIONS AND PHYSIOLOGICAL DATA (*Protocol 1*)

| Time | Concentrations of CO in Positions 1 | Concentrations of CO in Positions 2 | Remarks |
|---|---|---|---|
| *Minutes* | *Parts in 10,000* | *Parts in 10,000* | |
| 0 | 0.5 | 0.3 | engine started |
| 5 | 3.0 | 3.0 | exhaust gas = 5.6 per cent. CO (by Orsat). |
| 10 | 5.5 | 5.0 | |
| 15 | 6.5 | 7.0 | smoke very unpleasant. |
| 20 | 8.0 | 8.0 | engine stopped; smoke in chamber extremely irritating to eyes. |
| 30 | 6.0 | 6.0 | pulmonary air of H. W. H., a few minutes after leaving chamber, contained 3.1 parts CO; severe headache and some nausea for four hours; insomnia later. |
| 90 | 1.5 | ... | gas slowly diffusing out of chamber. |

At the end of twenty minutes the smoke in the chamber had become quite disagreeable and the engine was stopped. The dispersing fans were, however, continued in operation by means of an electric motor, and air samples were taken at intervals. The pulmonary air of H. W. Haggard, who had been in the chamber up to this time and who had been actively at work on the car, was taken a few moments after he left the chamber and analyzed. The data obtained are given in Table 3.

Protocol 2. — Feb. 11, 1920. The procedure was similar to that described in Protocol 1. Continuous and snap samples of air were taken during the period of gassing in three places: position 1, northwest corner; position 2, northeast corner; and position 3, middle of south side of chamber.

TABLE 4. — EXPERIMENTAL CONDITIONS (*Protocol 2*)

| Time | Concentration of CO in Positions 1 | 2 | 3 |
|---|---|---|---|
| *Minutes* | *Parts in 10,000* | *Parts in 10,000* | *Parts in 10,000* |
| 12 | 3.0 | 4.0 | 3.5 |
| 24 | 4.0 | 4.0 | 4.0 |
| 34 | 4.0 | 4.0 | 4.0 |
| 46 | 4.0 | 4.0 | 4.0 |

The number of persons in the chamber was eighteen — fifteen men and three women. Four subjects were seated about position 1, four about position 2, five about position 3, and the last five were ambulatory. The normal pulse and respiration were observed on each subject some time before gassing, and the same data obtained again soon after gassing. The air analyses were made by the iodine pentoxide method. The engine was allowed to exhaust into the chamber for six minutes initially, and the gas was then shunted to the outside for eight minutes. Thereafter, the exhaust gas was discharged into the chamber for one and one-half minutes in each ten minutes. Table 4 gives the conditions in the chamber as shown by analyses, and Table 5 presents the physiological data obtained from eight subjects — two typical of each group.

Protocol 3. — March 13, 1920. The arrangement of the engine exhaust previously described was altered by the introduction of a baffle can and a large gas meter into that portion of the piping which admitted the gas to the chamber. The volume of gas admitted into the chamber was thus more accurately controlled. A survey experiment, identical with the gassing procedure carried out in Protocol 2, was per-

TABLE 5. — PHYSIOLOGICAL DATA (*Protocol 2*)

| Subject | Sex | Position in Chamber | Duration of Exposure | CO in Pulmonary Air after Gassing | Pulse | | Symptoms |
|---|---|---|---|---|---|---|---|
| | | | | | Normal | After Gassing | |
| | | | *Hours* | *Parts in 10,000* | | | |
| C. Pepe | male | 1 | 1 | 1.12 | 90 | 74 | none |
| E. Shorr | " | 1 | 1 | 0.99 | 75 | 80 | " |
| E. Waters | " | 2 | 1 | 1.35 | 108 | 82 | " |
| M. Hotchkiss | female | 2 | 1 | 1.16 | .. | .. | " |
| M. Bell | " | 3 | 1 | 1.21 | .. | .. | " |
| E. Hilton | male | 3 | 1 | 1.06 | .. | .. | " |
| E. Levy | " | ambulatory | 1 | 0.99 | .. | .. | " |
| M. Snow | " | " | 1 | 1.27 | .. | .. | " |

formed. Determinations were made upon the air in the chamber and the pulmonary air of the subjects by the Haldane blood method. Observations were made on seventeen men and one woman. The subjects were for the most part quite active during this experiment.

The concentrations found by these methods, those estimated from meter readings, and analyses of exhaust gas by the Orsat apparatus, allowing for loss by diffusion, are shown in Table 6; the physiological data, which were obtained, in Table 7.

TABLE 6. — EXPERIMENTAL CONDITIONS[1]
(*Protocol 3*)

| Time | Exhaust Gas through Meter | Exhaust Gas by Orsat Analysis | Concentration of CO in Chamber |
|---|---|---|---|
| *Minutes* | *Cubic Feet* | *Per Cent.* | *Parts in 10,000* |
| 0 | 300 | 6.4 | ... |
| 10 | 80 | ... | ... |
| 15 | ... | ... | 6.8 |
| 20 | 75 | ... | ... |
| 30 | 82 | ... | 9.0 |
| 35 | ... | 6.6 | ... |
| 40 | 78 | ... | 8.6 |
| 50 | 78 | ... | ... |
| 60 | ... | ... | 9.3 |

[1] From the figures in column 4, the mean concentration of carbon monoxide breathed for one hour may be estimated to have been at least nine parts per 10,000 of air, and from the Orsat figures, column 3, perhaps two or three parts higher.

*Exposure of Horses to Exhaust Gas.* — A few observations were made on two U. S. Army artillery horses. They were of the Percheron breed and weighed between 1,400 and 1,800 pounds, one bay and the other white. We are greatly indebted to Colonel R. E. D. Hoyle, Commanding Officer, Field Artillery Unit, R. O. T. C., stationed at Yale University, for the loan of the animals.

The car and motor were taken outside of the tunnel gassing chamber and the exhaust gas piped to the inside. The horses were not hitched, but were allowed to move about freely inside the chamber. In each experiment a blood sample was drawn from the ear before and after gassing. The results of the three experiments are shown in Table 8.

Owing to the fact that the dispersing fans were not in operation we believe that the concentration of gas was quite variable in different parts of the chamber; and it is probable that the atmosphere which the horses actually breathed contained considerably higher concentrations of carbon monoxide than the figures given in the table.

## VI. Observations in Garages and in the Grand Central Station, New York City

The occurrence of fatalities in small private garages during cold weather has become so frequent an item of news that the public is becoming aware of the danger. Evidently if a car, while warming up, gives off 1 cubic foot of carbon monoxide per minute in a room 10 × 10 × 20 feet, the atmosphere will, apart from diffusion,

TABLE 7. — PHYSIOLOGICAL DATA *(Protocol 3)*

| Subject | Sex | CO in Pulmonary Air after Gassing | Pulse at Rest | | Symptoms |
|---|---|---|---|---|---|
| | | | Normal | After Gassing | |
| | | *Parts in 10,000* | *Per Minute* | *Per Minute* | |
| G. Gildersleve | male | 2.7 | 82 | 96 | dizziness, extreme headache and some nausea. |
| A. Vanderberg | " | 2.9 | 72 | 90 | throbbing headache for several hours, general lethargy for 24 hours. |
| A. Dreher | " | 2.2 | 82 | 105 | headache, nausea, chill. |
| J. Olean | " | 1.9 | 82 | 102 | dizziness immediately after gassing, sharp headache for 9 hours. |
| L. Peroff | " | 1.8 | 74 | 100 | throbbing headache for 9 hours. |
| M. O'Connell | " | 3.0 | 72 | 130 | frontal headache for 6 hours. |
| J. Fleming | " | 2.7 | 86 | 130 | severe headache, vomited, in bed 5 hours. |
| E. Waters | " | 2.7 | 82 | 120 | severe headache for 20 hours, legs weak. |
| M. Glazer | " | 2.7 | 60 | 84 | severe headache lasting 5 hours. |
| H. Farrell | " | 2.5 | 76 | 90 | severe occipital headache for 8 hours. |
| E. Tolstoi | " | 1.9 | 72 | 120 | severe headache, dizzy, nauseated, ringing in ears, for 7 hours. |
| E. Shorr | " | 2.5 | 74 | 116 | persistent headache and nausea for 8 hours. |
| H. Bailey | " | 1.6 | 75 | 80 | severe headache and nausea for 6 hours. |
| H. Langner | female | 2.2 | 72 | 108 | pounding in ears, violent headache and nausea, headache for 48 hours. |
| E. Wakeman | male | 1.8 | 50 | 60 | severe headache, faintness for several hours. |
| A. Wakeman | " | 2.0 | 54 | 68 | headache and nausea. |
| P. Susman | " | 2.2 | 80 | 120 | severe headache and vomiting. |
| J. Sigal | " | 1.8 | 72 | .. | very faint and weak, severe headache for 72 hours. |

reach the dangerous concentration of fifteen parts in 10,000 in three minutes. Owing to the insidious and usually accidental character of carbon monoxide poisoning in such garages, however, nothing bearing particularly on our problem is to be learned from them which could not be more accurately determined in our experimental chamber.

TABLE 8. — RESULTS OF EXPOSURE OF HORSES TO EXHAUST GAS

| Date | Time | Concentration of CO in Chamber | Percentage Saturation of Blood | | Remarks |
|---|---|---|---|---|---|
| | | | White Horse | Bay Horse | |
| | *Hours* | *Parts in 10,000* | | | |
| 3/17/20 | 1 | 2.5 | .. | 11 | no symptoms |
| 3/17/20 | 1 | 5.0 | 20 | 20 | " |
| 3/19/20 | 1 | 5.0 | 23 | 25 | " |

At first it would appear that important information might be obtained from the conditions occurring in large public garages and repair shops. On investigation of a number of such places we found that, even in those recently built and supplied (usually more or less imperfectly) with artificial ventilation, the employees frequently have slight headaches, while severe headache, nausea and emotional disturbances, ranging from mere unreasonableness up to hysterical mirth, anger or grief, or even maniacal manifestations, are not very unusual. There seems to be a general recognition that "it is not gasoline but the burnt gas" which produces these conditions. Our inquiries have also elicited information regarding an occasional death in which the victim had crawled under a car when its engine was running, or when the engine of a standing car ahead was "idling." When it came to getting samples of air for analysis from garages, however, we soon found that we could get anything that we wanted,

high or low, and that the figures had, therefore, little value without more elaborate supervision of the personnel than we could provide.

Conditions such as may occur in tunnels appear to be afforded in the taxicab driveway and stand below the Grand Central Railway Station, New York City. The general public passes through this place, many thousands per day. The taxicab drivers sometimes wait half an hour for a passenger, and the starters and markers are on duty for four or five hours at a time.

We learned on inquiry that up to a few months before this investigation a type of car had been in use which produced a considerable amount of smoke and that at that time headache and nausea were common. Recently, however, another type of car producing very little smoke has been introduced and symptoms of gassing appear now to be rare.

In order to define the conditions at the taxicab driveway and stand, members of the staff of this investigation spent several hours near the starters' position and took a number of samples of air for analysis, with the following results:

March 12, 1920. A mild, damp afternoon and evening. *5.45 P.M.* A sample of air taken soon after a number of cars had gone through contained 0.36 parts carbon monoxide in 10,000.

*9.45 P.M.* A sample taken after forty cars had gone through in fifteen minutes contained 1.36 parts carbon monoxide in 10,000.

*10.35 P.M.* After three cars had passed in ten minutes, the carbon monoxide concentration was 0.45 parts in 10,000.

*11.30 P.M.* Fifteen cars passed through in five minutes. A sample taken ten minutes later contained 1.78 parts in 10,000.

On another occasion a series of samples were taken and yielded the following figures: 0.45, 1.78, 0.36, 2.12, and 1.47.

It appears from these data that the air is occasionally vitiated for a time with as much as two parts of carbon monoxide in 10,000, but that with the ventilation provided by large fans the concentration of carbon monoxide soon falls again decidedly below one part in 10,000. There are now, so far as we can learn, no complaints from the public, and the taxicab drivers have only an occasional headache, when a line of cars stands for a long time with engines running.

## VII. Comparative Toxicity of Pure Carbon Monoxide, Illuminating Gas, Exhaust Gas from Gasoline, Exhaust Gas from Coal Distillate and Gasoline Vapor

The general agreement between the experiments with pure carbon monoxide mixed with air in Section II and the results with exhaust gas in Section IV indicates strongly that in the concentrations occurring in the large chamber carbon monoxide was the only substance of sufficient toxicity and present in sufficient amount to have any considerable physiological effect. All of the data in both of these series of experiments were, however, based upon low concentrations of the gas and the deductions from them might not apply equally to high and lethal concentrations.

We have, therefore, thought it well to check these results by means of observations on animals in high concentrations of gas. For this purpose dogs were used. The animal in each case was placed in a cube-shaped plateglass chamber measuring about 3 feet on a side. The gas to be tested was mixed with air in a gasometer of several hundred liters capacity, so that the carbon monoxide concentration was about 0.3 to 0.4 per cent., or thirty to forty parts in 10,000. From the gasometer the gas mixture was passed into the chamber through a tube by a small electrically driven air blower. Another tube from the chamber led outdoors. Usually the gas was run in at such a rate that the animal was at the point of death in thirty to thirty-five minutes.

The animal was then removed from the chamber and a sample of blood was drawn for analysis by the carmine titration method.

The technical details of the analysis of carbon monoxide in air and in blood will be found in the full report.

(*a*) *Experiments with Pure Carbon Monoxide Mixed with Air.* — In this atmosphere the animals became unconscious with no more apparent discomfort than if anesthetized with ether. The blood of five dogs at the point of death contained the following percentages of carbon monoxide: 87, 82, 84, 79, 88; average 84.

(*b*) *Experiments with Illuminating Gas Mixed with Air.* — In such an atmosphere the symptoms during intoxication differed in some respects from the preceding group. There occurred in all cases more rapid collapse and distinctly greater respiratory excitement. Nausea and vomiting, which were lacking in the experiments with pure carbon monoxide, occurred in all the animals of this second group. These observations and the fact that death ensued though a lower percentage of carbon monoxide existed in the blood indicate that illuminating gas contains some substance, or substances, which render it distinctly more toxic than an equal amount of pure carbon monoxide. The blood of the five dogs used in these experiments contained at the point of death the following percentages of carbon monoxide: 74, 67, 76, 71; average 70.

(*c*) *Experiments with Exhaust Gas from a Car Using Gasoline.* — For these tests the three commonest varieties of gasoline sold locally were used successively. A large rubber bag was attached to the exhaust of a car (one in good condition, with an efficient and smooth running engine), while it was standing with the engine running "idle." This gas was analyzed for carbon monoxide by means of an Orsat apparatus in the usual way. The gas was then mixed with air in the large gasometer to approximately the same concentration of carbon monoxide as in the previous experiments and was then administered to animals in the glass chamber. In these experiments the animals were at the point of death in approximately the same time as in the first series of experiments under (*a*) above. The symptoms were similar to those from pure carbon monoxide and unlike those from illuminating gas. The percentages of carbon monoxide in the blood were also similar to the first series, but higher than the second. Evidently carbon monoxide was here practically the only toxic substance. The blood of the five dogs used in this group of experiments contained at the point of death the following percentages of carbon monoxide: 84, 86, 83, 81, 81; average 83.

(*d*) *Experiments with Exhaust Gas from a Car Using Coal Distillate.* — For the opportunity to make these tests, we are indebted to the New Haven Gas Company which very kindly sent a car charged with coal distillate to the laboratory and allowed us to obtain a bag of exhaust gas as in the preceding experiments. Two dogs were exposed to this gas, exactly as the animals had been exposed in the previous experiments to exhaust from gasoline, and died with symptoms like, but more marked than, those of the dogs poisoned with illuminating gas. The blood of these two animals had a decided brownish tinge indicating a marked destructive influence upon the hemoglobin of the blood. It is known that benzol has such an effect.

The composition of the coal distillate, according to figures kindly furnished by the chemist of the Gas Company, was:

| | |
|---|---|
| Benzol | 69.0 per cent. |
| Tolnol | 15.5 " " |
| Solvent naphtha | 13.5 " " |
| Heavy naphtha | 2.0 " " |
| Total | 100.0 " " |

The blood of the two dogs used in these experiments contained at the point of death the following percentages of carbon monoxide: 60, 64; average 62.

(*e*) *Experiments with Gasoline Vapor.* — The results of our experiments with gasoline vapor are given in *The Anesthetic and Convulsant Effects of Gasoline Vapor*, by Howard W. Haggard (9).

## VIII. Principal Conclusions

The general standards at which we arrive (pp. 86–89* and 138) are: When the time in hours multiplied by the concentration of carbon monoxide in parts per 10,000 of air equals 3, there is no perceptible physiological effect. When it equals 6, there is a just perceptible effect. When it equals 9, headache and nausea are induced. When it equals 15 or more, the conditions are dangerous to life.

If the volume of breathing is increased by exercise (even by slow walking, and correspondingly more by physical work) the rate of absorption of carbon monoxide is increased proportionally.

* See the preceding issue of this Journal.

After return to fresh air, the elimination of carbon monoxide through the lungs proceeds at a rate of 30 to 60 per cent. reduction of the blood saturation per hour.

In the exhaust gas from gasoline, carbon monoxide is the only considerable toxic constituent. In the exhaust gas from coal distillate (benzol, etc.), and in illuminating gas, there are present accessory toxic substances.

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# BOOK REVIEWS

**The Community Health Problem.** By Athel Campbell Burnham, M.D., Health Service, Atlantic Division, American Red Cross; Attending Surgeon, Volunteer Hospital, New York City; Lieutenant Colonel, Medical Reserve Corps, U. S. Army; Fellow New York Academy of Medicine. Cloth. Pp. 149 and index. New York: The Macmillan Company, 1920.

This book is a brief and readable presentation of public health material, well suited for non-technical courses in general hygiene. The author has desired to give his readers a conception of the various fields into which preventive medicine has crept and the manner and success with which it has operated. Industrial hygiene is included in this group and receives brief but discerning treatment.

It is unfortunate that a chapter is not devoted to the various types of workers necessary in the different branches of community health, together with a certain amount of information as to their training. The practical usefulness of the book for elementary students would be augmented by such an addition. — *Cecil K. Drinker.*

**Human Efficiency and Levels of Intelligence.** By Henry Herbert Goddard, Director of the Bureau of Juvenile Research of Ohio. Cloth. Pp. 128. Princeton: Princeton University Press, 1920; London: Oxford University Press, 1920.

It is no exaggeration to say that this short series of lectures, delivered at Princeton University in April, 1919, enunciates a point of view that should not only be understood by everyone interested in efficiency and hygiene problems, but also by every citizen who wishes to cast an intelligent vote. Although no original work is published in the book, it brings together evidence from various sources in such a convincing, even dramatic way, that the reader finds himself awakened to the realization that the *doctrine of mental levels* is a social conception of the first magnitude.

The doctrine stands mainly on two well-established facts: first, that the intellectual development is largely independent of what we call learning or knowledge; second, that not all persons develop to the highest level or even near to it; many stop at some one of the lower levels of childhood.

The important thing for us to learn from the book is that the number of people of relatively low intelligence is vastly greater than is generally appreciated, and that this mass of low level intelligence is a menace to democracy unless it is recognized and properly treated. The data are obtained from several sources — the experience at institutions for the feeble-minded, the Bureau of Juvenile Research in Ohio, the statistics of the Department of Labor, school statistics from the Department of Education, and the report of the General Staff on Psychological Tests in the Army. The sources are authoritative, and the fact that remarkably similar figures are obtained from each source forces us to accept the statements as proven facts, however upsetting these facts may be to our preconceived ideas that we are all born equal. The army figures show that 70 per cent. of the 1,700,000 men examined were below the mental age of fifteen, and that 25 per cent. were morons. These figures being from the drafted army must certainly be a fair sample of our whole male population. The school figures from the Department of Education show that 67 per cent. of schoolchildren do not finish the eighth grade, and that 26 per cent. do not finish the fifth grade — a result remarkably parallel to the army figures. The Department of Labor tells us that 68 per cent. of wage earners get less than $15 a week — at least, an analogous observation.

Can we hope to have a successful democracy when the average mentality is thirteen? The answer is that the social efficiency of a group of human beings depends upon recognizing the mental limitations of each one and of so organizing society that each person has work to do that is within his mental capacity and at the same time calls for all the ability that he possesses. In short, whenever the 4 per cent. at the top of the scale choose to devote their superior intelligence to understanding the lower mental levels and to the problems of the comfort and happiness of the other 96 per cent., they will be elected the rulers of the realm and then will come perfect government. But that 4 per cent. must have what we call the "human quality" and must learn to take seriously the responsibility of their position — they must have the desire to make all people happy. Then, in a democracy where every person has the right to vote for those who shall rule over him, the masses will vote for the best and most

intelligent if they are made to feel that these same intelligent people have the welfare of the masses at heart.

The failure to appreciate the facts upon which the doctrine of mental levels is based has resulted in a vast amount of delinquency, and such delinquency impairs the efficiency of the total group to an extent little appreciated. It is no longer to be denied that the greatest single cause of delinquency and crime is low grade mentality. Apart from delinquency these people, in their present disorganized state, are extremely inefficient. It is their history (so constant as to be almost diagnostic) that they are constantly changing jobs. We have made no serious attempt to fit the man to the job. No attempt has ever been made to ascertain what grade of intelligence is required of any of the multitude of occupations. Some progressive employers in industries have inaugurated a sort of tryout system; but this is a crude makeshift in comparison to the results of a scientific determination of the mental level of the individual, coupled with a study of the amount of intelligence required for particular work.

"When one contemplates the enormous proportion of misfits that must exist in the industrial world and that such misfits mean discontent and unhappiness for the employee, one can but wonder how much of the present unrest in such circles is due to this fact. A man who is doing work that is well within the capacity of his intelligence and yet that calls forth all his ability is apt to be happy and contented and it is very difficult to disturb any such person by any kind of agitation." — *Stanley Cobb.*

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## FATIGUE AND ERROR IN A MENTAL OCCUPATION*

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RECENTLY some doubt has been thrown upon the use of output studies as a criterion of fatigue in industrial occupations (1). The data reported in this paper, however, show that the number of errors as well as the output varies during the day in a manner typical of fatigue curves. Link (2) in his investigations has used psychological tests as a method of studying fatigue, but although the tests were given at various times during the day, they showed very little indication of fatigue. In this paper output rate and error in a normally recurring routine operation of short duration are used as a measure of fatigue.

### PROCESS

Permission to work in the auditing department of a large railroad company was obtained through the courtesy of the superintendent, and the records of eighteen women clerks were compiled. The processes studied were the writing in of names on pay checks with pen and ink, and the typing in of amounts using a machine, in each case the name or amount being obtained from the payroll. Six women were engaged in writing in amounts, and twelve in writing in names. Three of the clerks worked on both processes.

It is the rule in this company that all pay checks must be numbered consecutively, and that the numbers of all checks on which mistakes are made must be recorded. Furthermore, the following data are kept in tabular form by the head clerk: time consumed in writing and comparing payroll vouchers—name of clerk, commencing number, closing number, number of names of payees written in with pen (or amounts typed in by machine)—time commenced, time finished, minutes, number of checks canceled.

### TREATMENT OF DATA

From the mass of data on the time consumed in writing and comparing payroll vouchers, I copied all the records for each of eighteen women clerks for the month of September, 1919. The total number of checks involved was 114,314. During this month the clerks had worked on pay checks on about fifteen to twenty days, but only for a few hours on each of these days, as a transcription from our data clearly shows. (Table 1.) The remainder of the time was

* The author wishes to acknowledge his indebtedness to Dr. E. G. Martin for advice and to Miss Edna Perry for assistance in connection with this paper. Received for publication April 26, 1921.

spent in the routine work of the auditing department.

The data were treated as follows: All the output records for one individual for one process were grouped together by hours. When a period extended into two hours the record was assigned to the hour nearest the center of the period — *e. g.*, 1.40–2.35 was put in the 2–3 hour, and 11.55–1.00 in the 12–1 hour. The output rate per hour was then calculated for each hour of the day and compared with the grand arithmetical mean of all the hourly records of the clerk. Calling the latter figure 100, by a simple proportion the figures of the individual hours were reduced to percentages of the grand average. This statistical treatment was gone through for each clerk and each process. The advantage of the data thus obtained is its freedom from differences due to skill and to the different speeds of the two processes of writing names and amounts. The percentage output for each hour for the whole group was found by obtaining the true mean of a frequency curve in which the percentage outputs for the hour for each individual were the quantities, and the number of checks on which each quantity had been based were the frequencies. This method was followed on the assumption that the percentage outputs having the largest number of checks as a basis were the most reliable.

TABLE 1. — SAMPLE OF DATA SHOWING TIME CONSUMED IN WRITING AND COMPARING PAYROLL VOUCHERS

| Name | Date | Number of Names by Pen | Number of Amounts by Machine | Number of Checks Canceled | Time Commenced | Time Finished | Minutes |
|---|---|---|---|---|---|---|---|
| H. . . . . . . . . . . . . . . | 9/5/19 | .... | 143 | 7 | 1:00 | 1:35 | 35 |
| | | 125 | .... | 1 | 11:10 | 11:40 | 30 |
| | | .... | 125 | 0 | (12)11:55 | 1:00 | 25 |
| | | .... | 151 | 6 | 3:00 | 3:50 | 50 |
| | | 156 | .... | 3 | (2) 1:40 | 2:35 | 55 |
| | | .... | 156 | 4 | 2:35 | 3:00 | 25 |
| | | .... | 172 | 6 | (4) 3:50 | 4:30 | 40 |

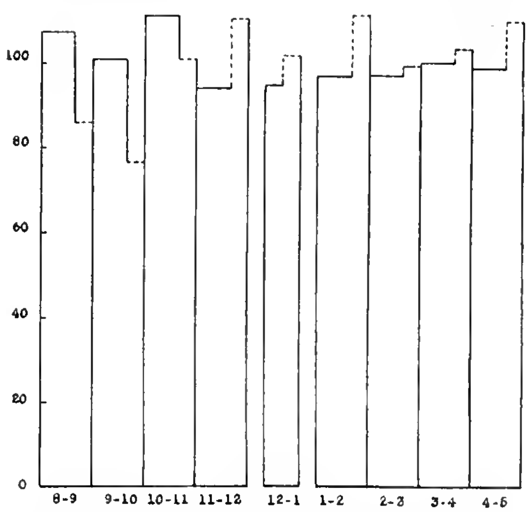


Fig. 1. — Solid line = percentage output rate by hours. Broken line = percentage error output rate by hours.

Checks were canceled when errors were made; therefore a record of the canceled checks for each hour and each individual gives the number of errors made. The percentage of error for each individual for each process and each hour was calculated and compared with the day's average errors as 100, and these figures were considered as quantities in a frequency distribution with the number of checks as frequencies, and the true mean obtained for each hour.

## Output and Error

The percentage output rate by hours is shown in Table 2 and Figure 1. It will be seen that the output rate starts at 106.8, falls to 100.5 in the second hour, goes up to 111.1 in the third, and falls at noon to 94.2. Lunch is had between 12 and 1 with forty

minutes allowed, therefore the output rate of 94.8 for this hour may not be significant. The output rate at 1 P.M. is 96.7 and increases to 100 by 3 o'clock, falling only slightly (to 98.8) at the end of the day. The output curve is, therefore, not very typical of fatigue; it shows, however, the characteristic higher output of morning (103.1) over afternoon (97.5).

The percentage output rate of errors by hours is also shown in Table 2 and in Figure 1. The percentage rate of errors starts at 86.1 falls to 76.6, then goes up to 110.3 at noon. At 1 o'clock it starts at 111.8 (the highest for the day), falls in the second hour to 99.9, then goes up to 109.4 at the end of the day. The morning average is 93.6, and the afternoon average 105.3 Not considering the 12–1 hour, the curve of percentage error output is the converse of a typical output curve. This is shown if we plot the reciprocals of the percentage error output, *i. e.*,

$$\frac{1}{\text{percentage error output}},$$

which we will call quality of work. This

TABLE 2. — HOURLY OUTPUT RATE AND RATE OF ERRORS

| Time | 8–9 | 9–10 | 10–11 | 11–12 | 12–1 | 1–2 | 2–3 | 3–4 | 4–5 |
|---|---|---|---|---|---|---|---|---|---|
| Hour | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| *Output* | | | | | | | | | |
| Mean | 106.8 | 100.5 | 111.1 | 94.2 | 94.8 | 96.7 | 97.3 | 100.0 | 98.8 |
| Standard deviation | 22.1 | 11.8 | 8.2 | 7.3 | 7.6 | 4.9 | 15.8 | 16.5 | 10.5 |
| Probable error of mean | 0.4 | 0.2 | 0.12 | 0.12 | 0.06 | 0.04 | 0.34 | 0.19 | 0.12 |
| Difference | | 6.3 | 10.6 | 16.9 | 0.6 | 1.9 | 0.6 | 2.7 | 1.2 |
| Probable error of difference | | 0.44 | 0.42 | 0.17 | 0.22 | 0.23 | 0.35 | 0.35 | 0.5 |
| Number of times P. E. D. is contained in difference | | 14.3 | 25.7 | 99.4 | 2.7 | 8.3 | 1.7 | 7.7 | 2.4 |
| | *A.M. Average 103.1* | | | | | *P.M. Average 97.5* | | | |
| *Error* | | | | | | | | | |
| Mean | 86.1 | 76.6 | 101.6 | 110.3 | 101.9 | 111.8 | 99.9 | 103.7 | 109.4 |
| Standard deviation | 34.2 | 20.0 | 26.4 | 28.4 | 34.1 | 33.8 | 25.6 | 28.9 | 37.3 |
| Probable error of mean | 0.21 | 0.1 | 0.12 | 0.14 | 0.25 | 0.27 | 0.18 | 0.21 | 0.42 |
| Difference | | 9.5 | 25.0 | 8.7 | 8.4 | 9.9 | 11.9 | 3.8 | 5.7 |
| Probable error of difference | | 0.23 | 0.15 | 0.18 | 0.28 | 0.37 | 0.32 | 0.28 | 0.47 |
| Number of times P. E. D. is contained in difference | | 41.3 | 167.0 | 48.3 | 30.0 | 26.8 | 37.2 | 13.6 | 12.1 |
| | *A.M. Average 93.6* | | | | | *P.M. Average 105.3* | | | |
| *Quality of Work* | 116.0 | 131.0 | 98.5 | 88.4 | 98.2 | 84.8 | 99.9 | 96.5 | 91.3 |
| | *A.M. Average 108.5* | | | | | *P.M. Average 94.1* | | | |
| *Efficiency* | 124.0 | 131.0 | 109.5 | 85.3 | 93.0 | 86.5 | 97.3 | 103.7 | 90.3 |
| | *A.M. Average 112.4* | | | | | *P.M. Average 94.2* | | | |

is shown in Table 2 and in Figure 2. The quality is good to start (116), better in the second hour (131), but then falls off to 88.4 at noon. It starts low in the afternoon (84.8), climbs to 99.9 in the second hour, and falls off to 91.3 at the end of the day. The morning quality average is 108.5 as compared with 94.1 for the afternoon.

The efficiency of the workers for each hour is determined by their output and the

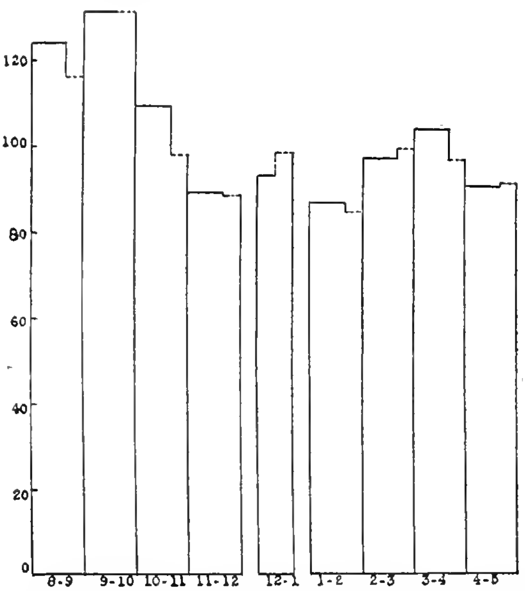


FIG. 2. — Solid line = efficiency by hours. Broken line = quality of work by hours.

quality of the work and may be obtained by dividing the percentage output rate by the percentage error output, for each hour. This is called the efficiency curve and is shown in Figure 2 and in Table 2. The efficiency starts high at 124 and climbs in the second hour to 131, then falls by noon to 85.3. At 1 P.M. it starts at 86.5, climbs to 103.7 in the third hour, and falls to 90.3 by the end of the day. The morning average is 112.4 and the afternoon 94.2. This curve has also most of the characteristics of a fatigue curve.

## Discussion

The data in Table 2 show that production is maintained more evenly throughout the day than quality. Thus, the difference between the highest and lowest percentage output hours is only 16.9, as compared with 35.2 for percentage error output. It is probable that the writing or typing is an automatic movement (3) in which the individual is unconscious of the figures read but conscious of the (voluntary) movements required to write the name or the number. In order to be aware of errors made, a higher form of consciousness — attention — is required. It would seem that the output is maintained by the lower type of consciousness, but the quality varies with the higher type of attention which is more readily subject to fatigue. Attention is more easily diverted than unconscious volition, and this may explain why the percentage output of error is more variable then the percentage output.

In this connection Spaeth (1, p. 32) says:

> . . . The question now arises as to what light the output curve throws on the occurrence of fatigue. We may say at once that if by fatigue we mean a lowered capacity for work, and the drop in output indicates a lowered capacity for work, it must simultaneously indicate, by definition, the presence of fatigue. How much of this fatigue is due to the work and how much to other conditions, output curves do not tell.

From the data above it would seem that even though the percentage output of the individual does not follow a fatigue curve very closely, the quality of the work does so to a very decided degree. It appears, therefore, that the decline in output at the end of the morning and the lower output of the afternoon are really indicative of fatigue — that is, if it is admitted that lessened attention is due to fatigue. The fact that production is maintained at so near a level throughout the day would indicate that the workers are endeavoring to keep up their output; in spite of this, however, the errors increase. It would seem, therefore, that real fatigue is the cause of the lowered output.

Link (2) made a study of the quality of the work done in a munition factory and concluded that "there was not enough difference in the quality of the work done at various times of the day to justify reducing the number of hours." He gives the following table (Table 3) showing the percentage of scrap that had escaped rejection by inspectors at various times of the day. The figures in parentheses in the table are mine and show the percentage of each figure of the average for the whole day as determined from the three figures given in the table. The percentage comparison (in parentheses) shows that the inspection work in the 5–6 hour is about 30 per cent. inferior to that of the morning hour. Therefore, Link's conclusion that "this increase is comparatively slight" (page 234) seems unwarranted.

TABLE 3. — PERCENTAGE OF SCRAP FOUND BY REINSPECTION (*AFTER LINK* (2))

| Time of Original Inspection | 7–8 A.M. | 1–2:30 P.M. | 5–6 P.M. |
|---|---|---|---|
| Number of boxes inspected | 47.0 | 26.0 | 37.0 |
| Percentage of total scrap found by reinspection | 12.2 (101.0) | 8.5 (70.0) | 15.5 (129.0) |
| Percentage of scrap (based on total number of shells inspected) found by reinspection | 3.9 (99.0) | 2.6 (66.0) | 5.3 (135.0) |

Link gave a number of psychological tests at different periods during the day from which he concludes (p. 237):

> The results in the tests, in so far as they were indicative, coincided largely with the results of the reinspection and production study. However, the variations in the quantity and quality of the work done in these tests were altogether too slight to justify using them as an index of fatigue. On the other hand, the variations due to practice were so marked as to make all other variations seem insignificant. This is not necessarily a repudiation of the psychological method, but rather an indication of the difficulties involved. It would seem that two-minute tests are entirely too short for reliability, even if carried on five times a day for a period of three weeks. Moreover, as has since been discovered in connection with the development of psychological tests for aviators, the human mind is able to concentrate for short periods even when it is almost on the point of exhaustion and render for such a time a performance which compares favorably with those done under the most favorable conditions.

From Figure 1 on page 235 of Link's paper, however, it appears that the number of errors in the 5.40 P.M. test was about 25 per cent. more than in the 1.10 P.M. test. As Link points out, a psychological test arouses the individual to unusual concentration of attention which may mask the effects of fatigue. Our use of a normally recurring routine occupation of a duration of only a few minutes as a measure of fatigue is therefore valuable in that it escapes the danger of arousing unusual attention by its nature.

## CONCLUSION

1. Output in clerical work shows signs of fatigue.
2. The error output in clerical work is the converse of an output curve.
3. The efficiency of clerical workers as measured by output and errors made varies like a typical fatigue curve.
4. A normally recurring routine occupation of a few minutes' duration is a valuable criterion of fatigue.

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# A WORK CHAIR *

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AND
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SURVEYS of twenty stores have disclosed a number of hygienic faults, one of the most evident of which is unnatural seating. Unnatural posture causes fatigue, reduces vitality, tends to deformity, and always results in reduced production and earning power. A careful search of chair salesrooms has disclosed the fact that no suitable chair is in stock which can be said to meet the anatomical and practical needs of the employee whose work is done at a desk or table.

In the past, chairs were evidently designed for resting, not for working. The common bent wood chair shown in Figure 1 supports only the shoulders when one leans back, and is an instance in point. The cane seat of this chair weakens rapidly so that the worker is soon sitting on a wooden ring crossing under the middle of the thighs.

A casual glance at any group of clerical employees at work will show a large proportion of them sitting forward on the front part of their chairs, as illustrated in Figure 2. This is an attempt to get comfortable. The back of the chair is used only during intervals of rest from fatigue produced by sitting with no support to the back. (See Figures 1 and 3.) Where does one need support when sitting at desk work? Try this experiment and see for yourself. Sit erect, and then gradually relax, letting the back bend naturally. You will find at once that the small of the back bulges directly backward. Here, then, is the need for support to maintain the erect position — the natural position for work. The weight of the body should be supported by a seat directly under the body and not at the mid-thigh. To meet these requirements of nature the chair shown in Figure 4 was made. It possesses a shallow seat and a back curved forward to fit the small of the back, and is of rigid construction in order to give support and steadiness. This chair has proved to be a generally useful work chair and considerable search has failed to discover any other which approaches it in essential requirements. Adjustable chairs may still be necessary for special work, such as that of the telephone switchboard operator, but adjustability is not an unmixed good. It nearly always results in unsteadiness and the chair is rarely correctly adjusted to the individual. Moreover, adjustability requires frequent repairs and results in a short-lived chair.

To introduce successfully any radical change in an individual's working environment — and a new work chair constitutes such a change — requires tact and care. It is suggested that at first a few samples be introduced, with careful explanations as to the object of the chair and with the suggestion that a fair trial be made before judgment is passed.

The work chair, which we have described, was especially designed by a committee composed of Dr. Joel E. Goldthwait (chairman), Dr. Lloyd T. Brown, and Mr. Ford, of Massachusetts Institute of Technology, to meet the needs of a large technical educational institution. It has proved entirely satisfactory, when used at a table or desk. Another similar chair, with arm rest added, was constructed for ordinary

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FIG. 1. — Resting posture in common bent wood chair.

FIG. 2. — Correct working posture in common bent wood chair.

FIG. 3. — Posture when sitting back in common bent wood chair.

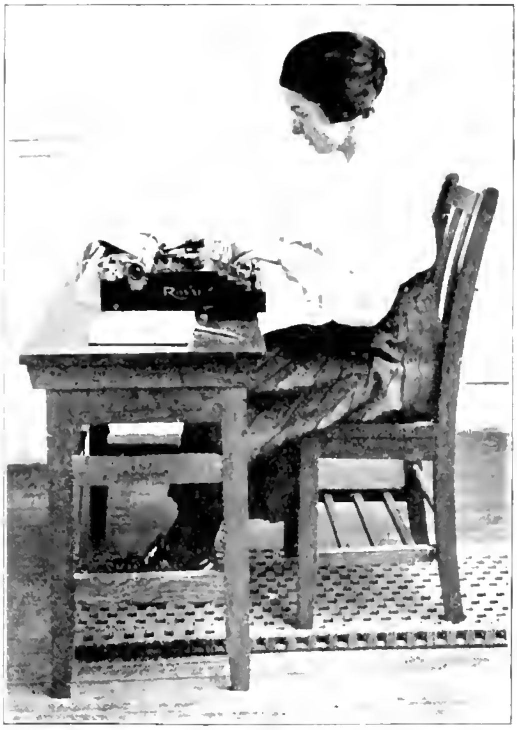

FIG. 4. — Correct working posture in work chair.

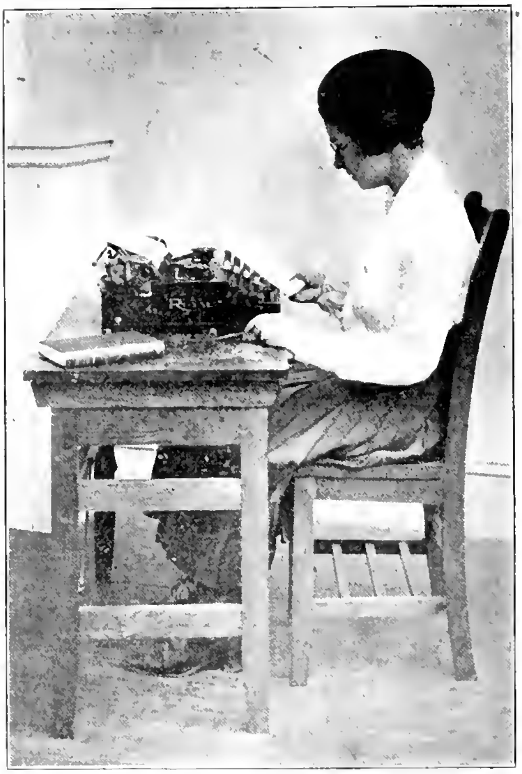

FIG. 5. — Correct resting posture in work chair.

FIG. 6. — Work chair.

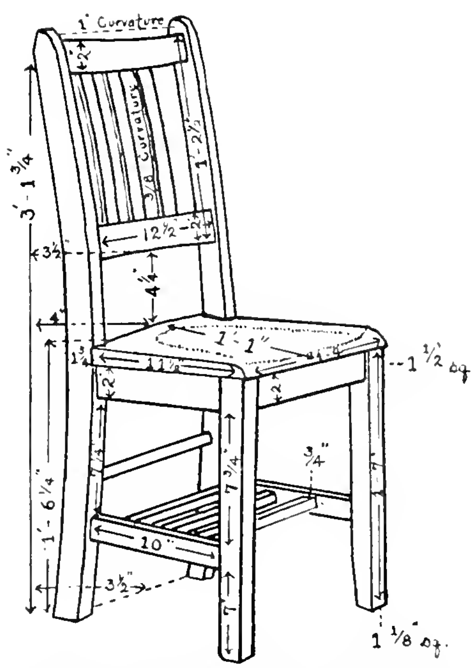


FIG. 7. — Manufacturer's measurements for work chair.

class room or lecture work. The sturdy construction of the chair is testified to by the fact that several hundred have been in constant use for five years and are reported to have received no repairs. Inspection of them at the present time shows that the glue has given way and needs replacement in about one in five to ten chairs; otherwise the chairs are in good condition.

The chair has had industrial use in a large clothing factory where many machines are used at tables. The personnel director of this establishment reports as follows:

We have found that the four different heights of the chair (17", 18", 19", 20") we use have been sufficient for all but one or two exceptional cases. The

FIG. 8. — Correct working posture in work chair.

FIG. 9. — Correct resting posture in work chair.

FIG. 10. — Incorrect working posture in common office chair.

FIG. 11. — Resting posture in office chair.

chair has worn very well indeed and is giving great satisfaction to the workers. As for its preventing fatigue, I cannot furnish statistics on this matter, but I do know that any chair which supports the back as this one does and which does not interfere with circulation must have a great deal to do with reducing the fatigue of our workers. I have used this chair myself ever since we first introduced it in the factory, and I wouldn't use any other as a desk chair. I feel that it has helped me to maintain correct posture, and that I am very much more comfortable in it than in any chair I have used as a work chair.

When we take into consideration the fact that many workers in stores, offices, and factories spend nearly a third of the twenty-four hours of a day in a chair, the importance of correct posture in preventing fatigue during working hours is evident. It is hoped that employees whose work must be done at a table or desk may be given the opportunity to use the work chair described in this article and to enjoy the comfort which it insures.

# THE PRACTICAL HYGIENIC EFFICIENCY OF THE PALMER APPARATUS FOR DETERMINING DUST IN AIR *

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In view of the recent publication of two rather severe criticisms of the efficiency of the Palmer water spray method of dust sampling, it has seemed to us that it would be advantageous to publish the results of some actual studies of dusty air made with the Palmer apparatus as compared with studies of sections from lungs of animals exposed to the same dusty air and with counts made directly from samples of the dust used in the tests. The criticisms referred to were those of Bill in his paper on *The Electrostatic Method of Dust Collection* (1) and of Katz *et al.* on the *Efficiency of the Palmer Apparatus for Determining Dust in Air* (2). Bill claims a relative efficiency of 61.6 per cent. by weight and 59.9 per cent. by count of the Palmer apparatus as compared with the electrostatic method, which later method he found to retain 82.3 per cent. by weight of the dust passing through his apparatus. Katz and his co-workers claim only a 70 per cent. efficiency for the electrostatic method and an efficiency of 30 per cent. or less for the Palmer apparatus.

It seems to us that the tests used by Katz and his co-workers were entirely too severe and not at all comparable to industrial conditions under which either apparatus is likely to be used. They start with the premise that the finest air-suspended particles are the most injurious to the lungs — a fact that has never been proved and that seems to us to be doubtful. Hoffman in a recent article (3) also conveys this idea when he speaks of "extremely fine dust, the ultramicroscopical particles of which are most harmful to the lungs." With all macroscopic foreign bodies, other things being equal, the larger the body the greater the irritation produced, and, of course, with soluble toxic particles the larger the particle the more toxic it is. It would seem to us that the largest particles that would actually reach the lung tissue would be most harmful and the particles that were most numerous in the lungs would be those most apt to produce gross lesions. Katz employed two methods of testing the apparatus, one with filtered tobacco smoke containing particles (droplets) of uniform size ranging from 0.2681 to 0.2779 microns in diameter. Efficiency was tested by the Tyndall phenomenon of luminosity of the particles floating in a current of air traversing a beam of light. Air passed through the Palmer apparatus was compared with air by-passed around the apparatus, percentage of suspended matter removal being calculated from the amount of filtered dust-free air required to dilute the latter sample so as to make the two beams of light of equal luminosity. This is a very ingenious method and the complicated apparatus required to make the test is most interesting, but the long, narrow, more or less tortuous tubing through which the samples are passed offers, as the authors state, abundant opportunity for precipitation of particles on the sides of the tubes. The test showed about 13 per cent. removal of these very minute droplets of liquid. Similar tests with finely divided dried silica dust showed a removal efficiency of 30 per cent. by the Tyndall method.

The second method employed by Katz was to collect the silica dust passing the Palmer apparatus in a small Cottrell elec-

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trostatic precipitator. The dust collected by the Cottrell precipitator was filtered through an analytic filter and weighed on the filter, the dust in the filtrate being estimated by a turbidity reading of the filtrate as compared with the turbidity of suspensions of known weights of the finest air-floated silica dust. This does not seem as accurate a method as that used by Bill and by Miller and Smyth (4) for determining the weight of dust collected by the Palmer apparatus. Just why the suspended water sample was not evaporated and the residue weighed, does not seem clear from the article. No direct measurements are given of the size of the silica particles used, but it is stated that those that pass through the analytical filter-paper average 0.25 microns in diameter. This method showed an efficiency of 45 per cent. by weight with this very fine dust. These tests show undoubtedly that the Palmer apparatus allows many minute particles to pass through, but they throw no light on the efficiency of the apparatus for sampling the average industrial dust clouds that contain many particles of much larger size which, as will be shown later, are still within the range of those that reach the lungs and remain lodged in the tissues.

In Katz's experiments, air was passed through the Palmer bubbler at the rate of 4 cubic feet per minute. Tests at a slower rate showed less efficiency, and tests at 5 cubic feet per minute, as recommended by Palmer, carried water through the apparatus. Bill, in his tests, used the same rate for the same reason. The work reported by Miller and Smyth (4) was mostly done at the 5 cubic foot per minute rate, the apparatus used being mounted in a dress suit case as originally designed and described by Palmer (5). The collecting bulb in this apparatus is larger than that in the later designs and has an extra bend in the outlet tube, and this is connected with several inches of upright and horizontal tubing before the fan is reached. With this original apparatus we have never known water to be carried over to the fan at the 5 cubic foot rate, and we always use this rate of sampling provided we have sufficient current for the fan motor. Many industrial plants manufacturing their own current use a 210 to 220-volt current, and by the introduction of a 110-volt lamp in parallel circuit and a four-point switch we have been able to use the same apparatus for tests in these plants and in plants using the usual 110-volt current.

Bill compared the Palmer apparatus with an apparatus of his own design, using a small Cottrell precipitator and running both types of apparatus for sixty minutes, which seems a much better sampling time than the one-minute periods of Katz. Bill used dusts passing a 100-mesh sieve which would much more nearly approach the average industrial dust than does tobacco smoke or the cotton-filtered silica dust of Katz, and would include, as will be shown later, the largest particles ever found in lung tissue. Bill found an actual efficiency of his own apparatus of 82.3 per cent. by weight and a comparative efficiency of the Palmer apparatus, as compared with his own, of 59.9 per cent. by count and 61.6 by weight, making an absolute efficiency by weight of 50.69 per cent. Bill claims that in counting particles in Palmer samples he was much more troubled by the clumping of smaller particles into masses which he often counted as units than he was with water suspensions of electrically precipitated dusts. Miller and Smyth and later we ourselves found that sufficiently vigorous shaking of samples and sufficiently high dilutions with filtered distilled water resulted in breaking up practically all of these clumps. In our counting work we dilute very turbid samples from 1 in 10 to 1 in 100, so as to have counts of under 100 particles per one-fourth field. This probably materially increases total counts and espe-

cially counts of smaller particles, and shows a greater percentage efficiency by count than was found by Bill, though even the approximate 50 per cent. efficiency of the Palmer apparatus as demonstrated by Bill does not materially affect its usefulness provided this percentage efficiency is reasonably constant and provided the apparatus gives a representative sample of particles of the most effective size. Bill's apparatus, while undoubtedly giving a decidedly greater percentage efficiency by count and by weight than does the Palmer apparatus, requires more delicate and skilful manipulation and more technical knowledge in order to run it and is as yet far from a portable and practical apparatus for routine industrial dust sampling. It is greatly to be hoped, however, as Bill himself suggests, that these latter difficulties may be overcome and that there may soon be designed and put on the market a small portable apparatus which can be used with reasonable facility and accuracy by the average field worker.

## Experimental Work

For over a year we have been doing experimental work along the lines followed by Mavrogordato (6), exposing groups of guinea-pigs to measured clouds of fine dust for given periods at given intervals. After given periods of time, the animals were killed and the effects of dust inhalations on the lungs were studied, the method of entry of dust to the lung tissue, the location of permanent deposits, the rate of invasion, and the route and rate of elimination of dust particles from the lungs all being noted. It is not the purpose of this paper to report on this work other than in one particular — that of the size of particles lodging in lung tissue. For this work a dust box was constructed similar to that described by Mavrogordato, a small electric fan being used to keep dust in suspension. A hole was so placed in the box that samples could be taken by the Palmer apparatus from alongside the exposed animals. Counts were made according to the method suggested by one of us (7), particles much over 40 microns in diameter being ignored and those counted being divided into three groups based on their greatest diameter rather than on their estimated area. The particles in group I averaged 40 microns, being sufficiently large so that their area could be easily estimated. Group II particles averaged from 5 to 30 microns in diameter and were large enough for their shape to be determined but many were too small for their area to be estimated. Group III particles averaged 1 micron and appeared under the low power as dots too small to permit us to determine their form.

Table 1 gives the size distribution of particles in watery suspensions of samples

TABLE 1. — SIZE DISTRIBUTION OF PARTICLES IN DUSTS USED IN TESTS

| Kind of Dust | Size I Av. 40 Microns Diameter | Size II 5–30 Microns Diameter | Size III Av. 1 Micron Diameter | Number of Particles Counted | Relative Weight of Equal Bulk of Dust |
|---|---|---|---|---|---|
| | % | % | % | | |
| Coal . . . | 2.9 − | 16 + | 81 − | 549 | 1.0 |
| Stone . . . | 0.78 | 9 − | 90 − | 2,529 | 1.8 |
| Flint | 0.3 | 2 + | 97 − | 4,385 | 1.4 |
| Average . | 1.3 + | 9 + | 89 + | . . . . | . . . . |

of the three dusts used up to the present time in these tests — *i. e.*, crushed coal used for fuel in cement kilns, crushed raw cement rock and crushed flint used in pottery manufacture. These dusts were commercial products obtained from a cement plant in the Lehigh Valley and from a flint mill in Trenton, N. J., and, as will be seen in Table 2, averaged smaller particles than those entrained in the Palmer apparatus in tests made several years ago of air dustiness

in the mills from which these samples were obtained. Tables 2 and 3 give the percentage distribution as shown in Palmer samples of all particles small enough to enter the fine

TABLE 2.—SIZE DISTRIBUTION OF PARTICLES IN INDUSTRIAL DUST TESTS WITH PALMER APPARATUS

| Kind of Dust | Av. Number of Particles per Cu. Ft. of Air | Number of Tests | Av. Weight of Dust per 100 Cu. Ft. of Air | Percentage of Particles | |
|---|---|---|---|---|---|
| | | | | Under 5 Microns Size III | Over 5 Microns Sizes I and II |
| | | | | % | % |
| Coal.... | 8,881,200 | 2 | 0.2286 | 53 | 47 |
| Stone... | 8,609,866 | 3 | 0.1681 | 55 | 45 |
| Flint ... | 844,040 | 3 | 0.0459 | 65 | 35 |

bronchioles and reach the lungs. Table 3 gives the results of counts of samples taken from the dusting box in which the animals were exposed and shows, by comparison with Table 1, that the Palmer apparatus, regardless of its total efficiency, seemed to take a fairly representative sample of the dangerous sized particles in these dusts.

Paraffin sections of portions of the lungs of guinea-pigs that had been exposed to the

TABLE 3.—SIZE DISTRIBUTION OF PARTICLES IN DUST TO WHICH GUINEA-PIGS WERE EXPOSED

*(As Determined by Palmer Apparatus)*

| Kind of Dust | Av. Number of Particles per Cu. Ft. of Air | Number of Tests Sampled with Palmer Apparatus | Av. Weight of Dust per 100 Cu. Ft. of Air | Percentage of Particles | |
|---|---|---|---|---|---|
| | | | | Under 5 Microns Size III | Over 5 Microns Sizes I and II |
| | | | *gm.* | % | % |
| Coal.... | 24,074,000 | 6 | 0.164 | 84.0 | 16.0 |
| Stone... | 4,719,000 | 12 | 0.046 | 93.25 | 6.75 |
| Flint ... | 15,009,000 | 6 | 0.0504 | 96.68 | 3.32 |

dusts for different periods and then killed by gas immediately after exposure, or at increasing intervals after, were stained and examined under the microscope. Simple alum-carmine staining permits the dust particles in the lungs to be seen clearly. The sections were examined under the oil immersion lens, and camera lucida drawings were made of a number of groups of intracellular particles. By this means a 2,000-diameter magnification was obtained and particles ½ micron in diameter and over could be measured. Table 4 gives the results of the measurement by these means of over 1,200 particles of the three dusts used; Table 5 gives the percentage distribution of particles grouped as over 5 microns (corresponding to sizes I and II) and under 5 microns (corresponding to size III). The

TABLE 4.—SIZE DISTRIBUTION OF DUST PARTICLES IN LUNG TISSUE OF GUINEA-PIGS

*(Stained Sections)*

| Kind of Dust | Number of Particles Counted | Greatest Diameter of Particles in Microns | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 11 | 8 | 7 | 5 | 4 | 3 | 2 | 1 | 0.5 |
| Coal............ | 616 | 1 | 1 | 3 | 14 | 4 | 41 | 87 | 117 | 348 |
| Stone........... | 378 | .. | .. | .. | 1 | .. | 4 | 21 | 76 | 276 |
| Flint........... | 295 | .. | .. | .. | .. | .. | 3 | 19 | 61 | 212 |
| Total particles counted....... | 1,289 | 1 | 1 | 3 | 15 | 4 | 48 | 127 | 254 | 836 |

latter are again divided into those under 1 micron and those from 1 to 4 microns. This division shows that apparently over 64 per cent. of the particles are under 1 micron, over 33 per cent. from 1 to 4 microns, with over 98 per cent. in the third class according to the Palmer count, while the dust itself showed an average of over 91 per cent. in the third class. Tables 4 and 5 show also an apparently decided difference in size distribution of particles of the lighter coal dust and the heavier stone and flint dust. Over 43 per cent. of the particles of coal dust found in the lungs were 1 micron or over in diameter, and particles as large as 11 microns were found, while less than 30 per

cent. of particles of either stone or flint were as large as 1 micron. The relative weights of the three dusts are shown in the last column of Table 1.

McCrae (8), in his studies on the lungs of South African hard rock miners, found that by acid digestion of lung tissue he could recover silica particles, 70 per cent. of which were under 1 micron in diameter, with 30 per cent. ranging from 1 to 10 microns in diameter. These results compare very closely with the counts made by us, as will be seen by referring again to Table 5 in which flint and stone dusts averaged 27+ per cent. of particles above 1 micron and 72+ per cent. under 1 micron, as against the 30 and 70 per cent. respectively counted by McCrae in miners' lungs.

TABLE 5.—PERCENTAGE DISTRIBUTION OF DUST PARTICLES IN LUNG TISSUE OF GUINEA-PIGS

*(Stained Sections)*

| Kind of Dust | Number of Particles Counted | Percentage of Particles in Size Groups: Over 5 Microns | 1–4 Microns | Under 1 Micron | Total under 5 Microns |
|---|---|---|---|---|---|
| Coal......... | 616 | 3 + | 40 | 56 + | 96 + |
| Stone........ | 378 | 0.2 + | 26 + | 73 + | 99 + |
| Flint ....... | 295 | 0.0 | 28 + | 71 + | 100 |
| Total particles counted | 1,289 | 1.5 + | 33 + | 64 + | 98 + |

Watkins-Pitchford and Moir (9) counted the doubly-refracting particles in sections of silicotic lungs ranging from 1 to 13 microns in diameter with a mean size of 6.13 by 2.18 microns, with particles up to 13 microns actually seen as intracellular. Later, by a method of cold digestion with strong nitric acid of the paraffin sections fixed on microscopic slides, they found that they had overlooked many particles and underestimated the size of others. After this treatment they counted and carefully measured 120 particles ranging from $\frac{1}{3}$ micron up to 5.5 microns in diameter, 35.8 per cent. being under 1 micron, 48+ per cent. from 1 to 2 microns, and over 15 per cent. above 2 microns in diameter, 1 micron being the most frequent size.

Sections from some of the same blocks of tissue from which stained sections were counted were treated by us according to the Watkins-Pitchford method of cold nitric acid digestion. Table 6 gives the results of these counts which compare closely with those of Watkins-Pitchford and Moir. We counted more large particles by this method than we did in stained sections, as did they. Although this method showed a surprisingly high percentage of large par-

TABLE 6.—SIZE DISTRIBUTION OF DUST PARTICLES IN LUNG TISSUE OF GUINEA-PIGS AS DETERMINED BY COLD ACID DIGESTION

*(Watkins-Pitchford Method)*

| Kind of Dust | Total Particles Counted | Greatest Diameter of Particles in Microns[1]: 23 | 17 | 12 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0.5 | Per Cent. over 12 Microns | Per Cent. over 5 Microns | Per Cent. 1-4 Microns | Per Cent. under 1 Micron |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coal........ | 506 | .. | .. | .. | 1 | .. | 2 | 1 | 4 | 4 | 16 | 78 | 331 | 69 | .... | 1.5 + | 84 + | 13 – |
| Stone....... | 477 | 1 | 1 | .. | 2 | .. | 2 | .. | 4 | 7 | 20 | 58 | 298 | 84 | 0.4 + | 1.6 + | 80 + | 17 + |
| Flint....... | 204 | .. | .. | 1 | .. | 1 | 2 | .. | 3 | 4 | 11 | 20 | 115 | 47 | .... | 3 + | 73 + | 23 + |
| Total....... | 1,187 | 1 | 1 | 1 | 3 | 1 | 6 | 1 | 11 | 15 | 47 | 156 | 744 | 200 | 0.1 + | 1.9 + | 81 + | 16 + |

[1] Most frequent size of all three dusts, 1 micron diameter.

ticles of stone and flint, yet the same relative distribution of smaller particles is seen. Coal dust showed only 13+per cent. of countable particles under 1 micron, and 65+per cent. averaging 1 micron in diameter; stone showed 17+per cent. under 1 micron, and 62 per cent. averaging 1 micron; and flint 23+per cent. under 1 micron, and 56+per cent. averaging 1 micron. With all three dusts the most frequent size found in the lungs was 1 micron (62+per cent. average), and there was an average of 81+per cent. from 1 to 4 microns. The same relatively high percentage of larger some clumping of very minute unmeasurable particles, yet these clumps were not very numerous and evidently were not the predominating factor, and hardly seem to be the factor apt to be responsible for much tissue damage. This would indicate that an average of 97+per cent. of the countable particles were among those counted as size III in the Palmer method according to Smyth's modification, as compared with 91 per cent. of the same size, counted in Palmer samples of the dust to which animals were exposed, and 89 per cent. in samples taken directly from the dust. The

TABLE 7.—COMPARATIVE SIZE DISTRIBUTION OF DUST PARTICLES AS SHOWN BY COUNTS OF DUST, OF DUST CLOUDS, OF STAINED LUNG SECTIONS, AND OF ACID-DIGESTED LUNG SECTIONS[1]

| Kind of dust | Av. 40 Microns | | | | 5–30 Microns | | | | Av. 1 Micron | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| | % | % | % | % | % | % | % | % | % | % | % | % |
| Coal | 2.9+ | 1.5 | 0 | 0 | 16+ | 14 | 3+ | 1.5+ | 81+ | 84+ | 96+ | 98+ |
| Stone | 0.78 | 1.5 | 0 | 0 | 9+ | 5+ | 0.2+ | 2+ | 90+ | 93+ | 99+ | 97+ |
| Flint | 0.3 | 0.07+ | 0 | 0 | 2+ | 3+ | 0.0 | 3+ | 97+ | 96+ | 100+ | 96+ |
| Average | 1.3+ | 1+ | 0 | 0 | 9+ | 7+ | 1+ | 2+ | 89+ | 91+ | 98+ | 97+ |

[1] 1 = Direct counts from dust.
2 = Palmer samples of dust.
3 = Stained lung sections.
4 = Acid-digested lung sections.

sized coal particles as compared with heavier stone and flint particles is seen here as is obtained by the direct counting of stained sections, though the difference is not so marked. Evidently, in the stained sections, many large particles of stone and flint appeared to be smaller than they really were, or probably were counted as more than one.

Table 7 is a comparison of percentage counts by all methods and shows a very close paralleling of size distribution of the countable particles under 40 microns in the original dust, the Palmer sampled dust, and the dust in the lungs of the exposed animals. While the tissue sections gave evidence by both counting methods of irregularity of the counts of particles over 5 microns in the different methods is explained by their relative infrequency in all tests.

These methods seem to indicate that a fair efficiency test of a dust sampling apparatus would include many particles of 1 micron in diameter and larger, and that failure to retain a high percentage of particles under 0.5 microns in diameter does not materially reduce its practical efficiency as a hygienic test. This is in practical agreement with and helps to confirm the opinion of the American Public Health Association Committee on Standard Methods for the Examination of the Air (10).

We are constantly exposed to and inhale

ultramicroscopic dust which is present in more or less degree in all air of inhabited regions. It is this type of particle that gives us our diffuse daylight and our beautiful sunsets, and that is responsible for much mist and cloud formation. These extremely minute particles remain in suspension indefinitely, as long as there are any air currents, being precipitated only in perfectly still air. In the bronchioles they would be the last particles to be deposited on the mucus, would float longest on the surface of the mucosa, would be the easiest to be swept up and out by the currents kept in motion by the cilia, and would be the least irritating when phagocytized. Ultramicroscopic particles are more apt to be spherical and less apt to be spiculate or to have sharp angles, and hard, spiculate or angular dusts are generally conceded to be most irritating and most apt to cause fibrosis. Especially with moderate degrees of dustiness, it would seem from the above considerations that the largest particles reaching the bronchioles would be the most irritating, and that of these larger particles the most dangerous would be the size occurring most frequently. This depends on the specific gravity and nature of the dust, and the efficiency of a dust sampling method should depend on its ability to retain a large percentage of these particles rather than of those of ultramicroscopic size.

As previously stated, both Bill's and Katz's tests with the Palmer apparatus were run at 4 cubic feet per minute, while we usually employ a 5 cubic foot rate with our type of apparatus. Katz states that he and his co-workers found a 30 per cent. efficiency by the Tyndall test when running at 4 cubic feet per minute, as against a 20 per cent. efficiency at 3 cubic feet — a ratio of 1.5 for the 4 cubic foot rate to 1 for the 3 cubic foot rate. Three comparative tests were run by us for five-minute periods against a very heavy cloud of coal dust which at the 5 cubic foot rate showed 1.3448 gm. of dust per 100 cubic feet of air. The tests were all run on the same day, the dust being freshly stirred up before each test so as to have as nearly as possible the same amount of dust in the air. There was

TABLE 8.—RELATIVE EFFICIENCY TESTS OF PALMER APPARATUS WHEN RUN TO SAMPLE 3, 4, AND 5 CUBIC FEET OF AIR PER MINUTE

*a. By Weight*

| Dust Employed | Duration of Test | Rate of Air Flow per Minute | Total Air Sampled | Weight of Dust Washed from Air | Calculated Weight Dust per Cu. Ft. of Air |
|---|---|---|---|---|---|
| | *min.* | *cu. ft.* | *cu. ft.* | *gm.* | *gm.* |
| Coal | 5 | 3 | 15 | 0.1004 | 0.66264 |
| " | 5 | 4 | 20 | 0.2012 | 1.006 |
| " | 5 | 5 | 25 | 0.3362 | 1.3448[1] |

*b. By Count*

| Dust Employed | Rate of Air Flow per Minute | Per Cent. Size I, Av. 10 Microns | Per Cent. Size II, 5–30 Microns | Per Cent. Size III, Av. 1 Micron | Calculated Number of Particles per Cu. Ft. of Air |
|---|---|---|---|---|---|
| | *cu. ft.* | | | | |
| Coal | 3 | 6.4 | 34.4 | 59.2 | 37,333,300 |
| " | 4 | 1.1 | 27.0 | 71.9 | 66,800,000 |
| " | 5 | 0.52 | 8.6 | 90.8 | 66,800,000[1] |

[1] Both count and weight should have been higher for the 5 cubic foot rate sample but there was so much coal in the collecting bulb that over 100 c.c. of sample was obtained before the bulb was completely rinsed out. Some of the coal remained in the bulb and was not included in the count or in the weighing test.

absolutely no evidence of any water being carried through the apparatus, and with the very heavy content of coal dust in the water this could not have escaped observation. These tests show (see Table 8a) the same relative efficiency as that found by Katz for the 4 cubic foot rate as compared with the 3 cubic foot rate, and a ratio of 1.33+ for the 5 cubic foot rate as compared with the 4 cubic foot rate. This seems to indicate that if Bill had used the older type of apparatus at a 5 cubic

foot rate he would have found it to have a relative efficiency of 81.8 per cent. by weight as compared with his apparatus; and with the same apparatus at the same rate, Katz would have found an absolute efficiency of approximately 59.85 per cent., instead of 45 per cent. at the 4 cubic foot rate.

Table 8b shows that the 5 cubic foot per minute rate also gives a greater efficiency by count than does the slower rate, and that the more active bubbling fountain entrains and holds back a great proportion of the smaller particles most apt to be harmful (size III).

## Summary and Conclusions

Our findings as to size distribution of dust particles in guinea-pig lungs agree closely with those of McCrae and of Watkins-Pitchford and Moir in human lungs.

The most frequent sized dust particles lodging in the lungs of men or animals are those about 1 micron in diameter, and from 60 to 80 per cent. of the countable particles are from 1 to 5 microns in diameter. There is no evidence of a great accumulation of ultramicroscopic particles in the lung, and these particles are not so apt to reach the lung cells as are those which are somewhat larger.

Dust particles seen in stained sections of the lungs are apt to appear smaller than they really are, as is shown by the Watkins-Pitchford method of cold acid digestion.

The Tyndall phenomenon, depending largely on the presence of ultramicroscopic particles in the air, although the best absolute test of complete removal of particulate matter, is too severe a test of the practical hygienic efficiency of a dust sampling apparatus. Efficiency tests for such apparatus should be made with dusts containing particles at least as large as 10 microns in diameter, and the most frequent size in such test dusts should be 1 micron in diameter.

With dusts having particles ranging up to 40 microns in diameter, and with an average of over 89 per cent. of particles under 5 microns in diameter, the Palmer apparatus run at 5 cubic feet per minute collects representative samples with nearly the same size distributions. A five cubic foot per minute rate is the most efficient for the Palmer apparatus as originally designed, and does not carry any water through the apparatus. At this rate, it is at least 1.33 times as efficient as is the new design run at the 4 cubic foot per minute rate, as was done by Bill and Katz. At the 5 cubic foot per minute rate the Palmer apparatus should have an efficiency of almost 82 per cent. by weight as compared with the Bill electrostatic apparatus. At this rate the increase in numerical efficiency and the percentage of smallest sized particles are both decidedly greater than at the 4 cubic foot per minute rate.

The electrostatic method of dust sampling as used by Bill would undoubtedly be the best method, provided a simple, easily manipulated, portable apparatus were devised.

The clumping of minute particles in Palmer dust samples as objected to by Bill can usually be overcome by sufficient dilution and shaking, which will greatly increase the numerical efficiency of the method. At present the Palmer apparatus is the most efficient practical dust sampling apparatus at our disposal for hygienic tests in industry.

The Kotzé konimeter (10) was not considered in the above comparisons because, regardless of its absolute efficiency or its efficiency for sampling dangerous sized particles, it collects too small a sample over too short a period to give an idea of the amount of dust to which a laborer is exposed in his daily work.

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# PHYSICAL EDUCATION FROM THE STANDPOINT OF THE INDUSTRIAL PHYSICIAN*

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ONE of the chief functions of an industrial medical clinic is that of a "diagnostic clearing house." Yet, too often, this real opportunity for service is lost sight of in the routine treatment of trivial cases and the dressing of minor injuries. Even physical examinations are made in a methodical manner and the cards filed without any attempt being made to cull out the cases which could be benefited by simple hygienic measures. An applicant is rejected or employed with little or no thought beyond the fact that he is either fit or unfit. Too often he is not even told why he is rejected, and as a result he drifts from one industry to another until he finally gets a job in a factory that does not require the physical examination of applicants.

In many of our better organized industries, physical examinations are required of all applicants for employment. Re-examinations are made at periodic intervals, at least once a year, and more frequently if it seems advisable to the examining physician or to the foremen or superintendents of departments. Re-examination is beneficial to the employer because it gives him efficient workers; to the employee because it serves to keep him in good physical condition; and to the examining physician because it gives him valuable information as to conditions under which certain defectives do well. Very often applicants and old employees who are manifestly physically below par present themselves for examination, and yet it would be a simple matter to raise them to an average standing of physical fitness if a physical education department, thoroughly organized under efficient leadership, were available, as it were, to fill the prescription of the examining physician. I believe that one of the most important functions of the present day industrial physical training department is to carry out, under the direction of the medical department, such measures as may help to restore the applicant or the employee to normal health. Then, too, there are the abnormal cases which require special care —persons with defective hearts, those with arteriosclerosis and high blood pressure, those who are greatly overweight or underweight, or those who are poorly nourished and whose resistance is manifestly low. We industrial physicians are comparatively helpless without someone to assist us in the upbuilding of these bodies which need individual care rather than routine work in gymnasium classes. It would be foolish to prescribe the same drug in all cases of illness with the thought that it would be a cure-all. Is it not equally absurd to expect the same form of exercise to benefit individuals irrespective of their physical defects? The physician and the physical director should hold a consultation over each individual case in order that the physical director may be fully informed in regard to the condition which he is to try to remedy. Otherwise, a heart only slightly involved may be permanently damaged, or an overtaxed circulation broken down by misdirected efforts.

In several industrial institutions groups of employees are assembled on a gymnasium floor or an adjacent field and put through a series of exercises. Calisthenics are a bore to the majority of people, and

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apparatus work is too difficult or monotonous for the average person to approach with any degree of enthusiasm. Glowing reports of the success of these group classes are received but individually the employees say: "We have to do it because the boss does. We would rather be playing ball." Play! That is the answer — the spirit of competition, the elemental desire in each heart to excel the other fellow.

The tendency in some industrial physical training departments is to develop teams very closely verging on professionalism. In many of our industrial leagues the sole object seems to be to organize such teams for advertising purposes. In fact, many ex-professional athletes are given a nominal place on the payroll merely so that they may participate in athletics. This is closely analogous to the old custom of hiring professional athletes to attend college and giving them their tuition and board in return for their participation in certain forms of athletics. In a recent conference a group of men engaged in industrial physical training deplored this tendency and agreed with the physicians present that this should not be the sole object of physical training in industry. On the other hand, there is the human factor that must be considered — that is, the reluctance which most of us have to engage publicly in a sport in which we realize that we are not very proficient. We would rather sit on the side lines and watch others play ball or tennis, or engage in field events, than to go in and try them ourselves and be laughed at because we are "dubs."

There, I think, is the important problem to be solved. How are we to get the bench warmers out on the field? Certainly not by encouraging the development of so-called professional industrial teams, but rather, it seems to me, by the development of playground activities. In one factory which I recently visited the building was locked during the noon hour and all the employees went out of doors as soon as they had finished lunch. I saw more people playing volley ball at one time in that yard than I have ever, before or since, seen playing the game. Besides volley ball there were several games of indoor baseball and two games of ordinary baseball going on, while over in one corner of the yard a number of fellows were pitching horseshoes. Nearly everybody was doing something and but few were looking on. Some, it is true, had left the grounds and gone for a walk, but no one returned to the factory directly after luncheon.

A point that should be emphasized as essential to the success of outdoor recreation is that the playground should be close to the factory, preferably on the same lot, in order that it may be reached with no loss of time and in order that there may be a feeling of greater freedom among the employees because they are, so to speak, playing in their own back yard. If this scheme of playground activities could be still further perfected by being organized under the direction of a playground leader, much more might be accomplished than under the present system.

There is one beneficial result of playground activities that is permanent; when the weather becomes inclement these young people, who have become accustomed to play for a half or three-quarters of an hour during each noon recess, will miss their play time and will naturally drift into the gymnasium during the winter months. The gymnasium, therefore, is in this way secondary to the playground, and with bowling, basket ball and other indoor sports will continue the beneficial habits formed by play in the open. One serious drawback to gymnasium work, however, is that so few can enjoy it at one time, and therefore our problem is again to make the spectator play. This may be accomplished by providing as means of recreation

other amusements which require little or no equipment, such as dancing, for which only a phonograph is necessary; indoor quoits; checkers; and singing, which is extremely good breathing exercise. Not long ago I heard two or three hundred young people sing in a factory dining-room after lunch. One of the foremen acted as leader and one of the girls accompanied them on the piano. And how they did enjoy it! Yes, I sang too, as did everyone else.

Practically all outdoor sports and recreational activities that have been participated in by women and girls are but adaptations of sports and games indulged in by men and boys. Baseball, for example, is not a natural game for a girl to play and very few girls make good ball players. The same may possibly be said of basket ball. It seems, therefore, that there is a large field still open for the development of games especially applicable to the needs of women.

It is not the purpose of this paper to go into the great subject of fatigue, nor to point out the methods of measuring fatigue, but we must acknowledge that it constitutes the most difficult problem to solve in all industrial relations. Fatigue is the most common cause of breakage, of wastage, of poor quality of product, of accidents, and of lessened production. Some writers say that there is no such thing as fatigue, that it all resolves itself into an antipathy aroused by monotonous occupation. Manifestly this is not so. However we may approach this subject, however skeptical we may be from a medical standpoint, we do see evidences of fatigue among workers. This is especially true among those engaged in piecework in shops where there is a long working day. If you doubt this, try it yourself. Pick out some simple manufacturing process that is easy to learn and then sit down and do that bit of work for four successive hours. Then eat a light lunch and go back to work after half an hour for another four or five hours. As a result you will be very tired, nervous or unstrung and, undoubtedly, irritable. It has been said that, if fatigue causes a net loss of five cents a day to each worker in the United States, in a year it will amount to the stupendous sum of $300,000,000. There must be some remedy for fatigue, but it is not a universal remedy and therefore cannot be applied as a general rule, but must be adapted to each process of manufacture after an exhaustive study of that particular industry.

Many processes in industry are in themselves fatiguing either because of the monotony of the operation or because of the physical effort required to do them well. Among the workers engaged in such processes there are always some who for no apparent reason lag behind in production, especially if they are doing piecework. Sometimes this is so apparent that it is manifestly due to some inherent defect in the technic, too long hours or poor hygienic surroundings. Personally, however, I believe that it is monotony which has this effect, and that in order to overcome this and thereby decrease spoilage and accidents and increase production it is necessary to have recess periods during the working hours. No definite rule, however, can be laid down for these recesses. In office work it is a simple matter. All that is necessary is an opportunity to move about and if possible, under suitable direction, to take some simple relaxing or corrective exercises with the windows open. I have seen this experiment tried out in one office, and the manager says that exercises are now an accepted part of the day's work. Certain trade unions have specified in their agreements with their employers that a definite amount of time be given each day during the working hours for relaxation. They have found this necessary because of the nature of the

process of manufacture. On the other hand, there are a vast majority of workers who need these recess periods but who do not realize their need, and whose employers are also oblivious to this cause of fatigue. Physical relaxation and exercise during working hours are of great importance and should be given careful consideration by each plant manager after he has made a careful survey of physical conditions of the operators and processes, with the aid of his medical staff. Conditions vary, and remedies must, therefore, be chosen to meet existing conditions.

In the large cities where many workers must spend from one hour to three hours each day going to and from the factory, the question of games and sports outside of working hours must often be limited by the time available. It is practically impossible to induce anybody to remain for an hour or so after work to take up any form of recreational activity. A few may stay and play baseball or bowl, but the majority choose to go home. They are tired and hungry, and they want to get out of their working clothes. It is apparent, therefore, that if exercise out of working hours is to be indulged in by the majority of workers, it must be arranged for in the middle of the day. If the working day is eight hours long, there should be at least one hour at noon for a light luncheon and recreation. Again games are the best means of relaxation, but these games should be simple; first, in order that all may play and, secondly, in order that they may be completed in the brief time allotted. Naturally, the physical instructor should here become the playground director, and it is his duty to arouse the interest of the bench warmers and keep things moving.

In all of our industries one encounters the sad spectacle of twisted hands and fingers, ugly deformities and scars with resulting contractions. I believe these are a blot on a community, a disgrace to industry and a shame to the medical profession. They should be eliminated, and they can be by co-operation between the physical education department and the medical department. But you say that methods for the relief of these deformities are expensive, that the cost is prohibitive for any one factory. True, but why should not combined industry contribute toward local hospitals and see that a ward or building is suitably equipped and maintained for the care of this class of patients? Imagine the tremendous saving not only of dollars, but of thousands of dollars, annually if the stiffened fingers and hands could be treated and kept limber and functioning. After it is too late, after adhesions have formed and the need is only too apparent, a belated attempt is made to correct the impossible. Treatment should follow immediately upon the surgical procedure; the injured fingers should never be allowed to become stiffened and contraction should never be allowed to occur. But it is only by individual care and by constant supervision and manipulation of these crippled members everyday, sometimes every two or three hours, that successful results can be obtained. In a certain city of a million inhabitants, with 3,000 industries, there is not even one well-equipped hospital or dispensary to handle the vast multitude of such cases that present themselves each year.

Perhaps it is not the function of a paper of this character to mention the beneficial effects of preventative measures applicable to club feet, flat feet, and other acquired or congenital deformities that are occasionally seen in industrial clinics, and yet we know that many of these conditions even could be helped or prevented by simple measures similar to those which have been mentioned above for the treatment of occupational deformities.

The chief criticism that has been made of this rather extensive program for phys-

ical education is that it would be expensive to put into operation. It would require the services of a man well trained in gymnasium and playground activities, and would necessitate the installation of more or less expensive equipment. There is no reason why a beginning, however small, could not be made in almost all industries. The first requisite is a vacant lot. The tendency is for young people to play wherever there is a vacant piece of property. They may be interested in baseball or some other outdoor sport, but in any event, they tend to gather together and to play something. If somebody can be secured to direct them, even though it be a volunteer from among their own numbers, it will be a beginning which is sure to bear fruit in the long run. I do not believe it is the province of industrial organizations to try to reach the high standard of equipment which has been installed in some places and which is so elaborate that the expense is prohibitive to most companies. But at any rate let us make a beginning. The workers themselves will take care of the rest as the spirit of play becomes a part of the routine of their day's work.

The industrial executive has three problems always before him — production, quality, and people. He feels that it is the function of the medical department to provide him with workers physically able to give him the maximum production, and realizes that the quality of output, too, is inseparable from good health and good spirits. The medical department and the physical education department cannot fail to succeed if they will work together and strive to co-operate with executives on the one hand, and the workers on the other.

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## HEADACHE*


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"HEADACHE" is certainly one of the most frequent complaints among industrial workers — any physician working in an industrial community knows this fact in a general way. This paper is written to focus our attention on headache as a symptom, and, by giving brief data collected in factories and department stores, to stimulate other workers in the field to make more extensive studies.

In a factory industrial unit employing 12,000 workers, Mock's (1) analysis of the cases of time lost in a year showed that in approximately 23 per cent. the complaint was headache (Table 1). One of us,† working in mercantile industrial units, found that from 10 to 15 per cent. of all employees asking for medical attention complained of headache. One department store had an average of 1,500 employees. Table 2 shows the number of cases seen each month and the number and percentage of these cases complaining of headache. In a smaller store employing about 800, with a greater number of women, a tabulation for four months showed even a larger percentage of headaches (Table 3). In both establishments more women than men were employed, and in the smaller store, where there was a larger percentage of female employees, the number of headaches was greater. Mock's figures also showed that more women com-

TABLE 1.—NUMBER OF LOST TIME CASES DUE TO HEADACHE AMONG 12,000 FACTORY WORKERS

| Sex | No. of Cases of Lost Time in a Year | No. of Cases Due to Headache | Per Cent. Due to Headache |
|---|---|---|---|
| Male | 6,420 | 1,255 | 19 |
| Female | 15,244 | 3,778 | 24 |

TABLE 2. NUMBER OF CASES OF HEADACHE AMONG 1,500 DEPARTMENT STORE EMPLOYEES

| Month | Total Cases Examined | Headaches | |
|---|---|---|---|
| | | Number | Per Cent. |
| 1st | 670 | 64 | 9.5 |
| 2d | 554 | 59 | 10.6 |
| 3d | 767 | 65 | 8.4 |
| 4th | 1,000 | 145 | 14.5 |
| 5th | 775 | 84 | 10.8 |
| 6th | 685 | 69 | 10.0 |


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plained of headache than men, in the ratio of 24 to 19. This is probably due to sexual differences — for example, menstrual difficulties and "nervous instability" — although the contention that women as a group are less stable than men cannot be shown conspicuously by any statistics with which we are familiar.

Francis A. Brugman (2), in the beginning of his recent paper, *Etiology of Chronic Headaches*, says that there are so many factors entering into the causation of headaches, and so many different ways in which the pain may present itself, that no particular pathological condition can be said to cause any particular kind of headache. He further says that some idea may be had of the problem confronting the diagnostician when one observer has given a list of 160 conditions which may cause headache. Hence only the more common conditions can be referred to here.

TABLE 3. — NUMBER OF CASES OF HEADACHE AMONG 800 DEPARTMENT STORE EMPLOYEES

| Month | Total Cases Examined | Headaches | |
|---|---|---|---|
| | | Number | Per Cent. |
| 1st | 651 | 100 | 15.3 |
| 2d | 502 | 73 | 13.9 |
| 3d | 541 | 80 | 13.7 |
| 4th | 691 | 85 | 10.2 |

Most authors make painstaking classifications of the different forms of headache; for example, Brugman's division into *reflex*, *congestive*, *toxic* and *neurotic* is better than most classifications; but in all fairness we must admit that we know so little of the physiological pathology that to use the words, reflex, toxic and neurotic, is simply to cover our ignorance of the mechanism involved with vague names. Congestion we can easily demonstrate, for we know that a tight collar will cause a headache, and we can show in the laboratory that pressing on the jugular veins causes cerebral congestion and raises intracranial pressure.

Even though we know little definite about etiology, clinical experience has clearly indicated certain factors in the causation of headache, and additional evidence has been gained by therapeutic experiments. Therefore we will classify these headaches according to their probable etiology, considering first those causes which were most commonly met with in the department stores above mentioned.

The most frequent cause seems to have been the onset of *an acute infection*, usually of the upper respiratory tract — the common "cold" or "grippe." A liberal use of the clinical thermometer and a few questions will make the recognition of this type a simple matter. *Constipation* was next in importance. Here the headache is usually dull and diffuse, and the diagnosis is generally made from the history. But constipation is seldom an isolated cause; it is usually associated with *poor hygiene* — *e. g.*, lack of drinking water and other faults of diet, lack of sleep, and work at home as well as at the store, all contributing to make a picture of general fatigue. Frequently this is the forerunner of some incipient disease. Anemia may be an important factor.

This class of headaches, however, cannot be sharply divided from the great group of *psychoneurotic* headaches, for faulty mental hygiene usually leads to bad physical hygiene or *vice versa*, and a vicious circle is easily formed, from which the patient finds it impossible to escape. Advice as to regular habits, followed up by supervision, is often all that is necessary to break the circle. With the physical condition thus improved, the mental symptoms may become inconspicuous. While no one cause can be given in such a case, the combination of various circumstances at a given time burdens the patient to the breaking point. For relief it is not necessary to remove all the untoward circumstances, in fact it is

impossible—for we all carry some burdens, physical or mental—but a removal of part of the burden will usually allow the patient to get rid of the symptoms that are interfering with economic efficiency and happiness.

Many cases will be encountered, however, particularly in department store work, where simple rules of hygiene will do little good. These cases can be considered psychiatric, and a careful study will elicit emotional factors, poor adaptations, dissatisfaction with life, worry, or other environmental difficulties. For example, an employee may be worrying over decreased sales and fear of reprimands by superiors; another may be having difficulties in his home life, causing emotional instability; in both cases there is a resulting lack of energy and poor physical hygiene, for when our spirits are depressed our bodies feel "tired" and we do not have the energy to follow a healthful routine. The headache is a defence against irksome effort; the patient is unhappy, vaguely dissatisfied, and craves attention, pity, relief from monotony. A slight headache, which in another individual (or in this patient at another time) would cause no disability, is seized on as a means of escape from the situation and is exaggerated until the patient obtains the relief desired. These mental mechanisms are largely subconscious, and to tell such a patient that the headache is "imagination" is not only to show gross ignorance of the psychology involved, but it is bad therapeutics, since the patient is antagonized and can never be led to understand the real cause. Success is only obtained by sympathetic investigation of all the mental factors, followed by frank talks in explanation of the symptoms. In obtaining the facts in these cases, which are usually of a personal nature, a well-trained and tactful social worker is an invaluable adjunct to the medical staff.

Many psychoneurotic headaches are directly caused by neuromuscular tension. Whenever we are over-stimulated, uncontrolled and useless energy is likely to be spent by contracting the muscles of our neck, face, scalp, or even of our extremities. Common examples are seen in the set jaw and the drawn face. Such muscular tension long continued may set up definite headache; indeed, it is a common cause since the over-stimulation responsible for the tension may come either from external sources, such as continuous noise, or from internal emotional conflicts. Perfectly normal people subjected to stress often suffer thus, but the supersensitive psychoneurotic is much more susceptible.

In our experience, *eyestrain* was a frequent cause of headache. Clarke (3) considers it by far the commonest (quoting Lauder Brunton as saying that 90 per cent. of all headaches are due to eyestrain), but this would seem to be an exaggerated statement, unless we accept Charles' (4) theory that local eyestrain causes headache only when the patient is neurotic. These cases then would be classed with the great group of psychoneurotic headaches, and would be best explained by postulating that most normal people have slight feelings of pressure or other cranial discomfort after eyestrain, but that it is only in unstable people that this degree of pain amounts to disability. By what mechanism eyestrain produces headache, we do not know. Many elaborate theories have been advanced, the most reasonable of which seems to be that the effort of accommodating with a refractive error, or of converging in spite of a muscular imbalance, causes a muscular tension analogous to those described above. Even this theory gives little clue to the actual mechanism involved, although the fact that those headaches which are most relieved by glasses are usually frontal or orbital suggests that local muscular tension may be a factor.

The last group of headaches which could be considered common among these em-

ployees was the group arising from infections of the nasal sinuses. The pain in these cases is intense, and tenderness can usually be elicited over the offending sinus. The history of rhinitis and examinations by transillumination and X-ray will aid in the diagnosis.

Before going on to a discussion of the kinds of headaches less frequently encountered in this group of workers, it would be well to discuss a vague but important entity — the *fatigue headache*. This is such a mild symptom in most people that it seldom is brought to the attention of the physician. In psychoneurotic patients it is often the central symptom. It is a common experience that excessive work will cause a feeling of pressure about the head, as if the temple were clamped in a vice, or as if an iron band were pressing about the forehead. The precipitating cause of such discomforts may be either physical or mental strain. When arising from physical strain, fatigue headache usually occurs in an individual who is not accustomed to labor and who leaves his sedentary occupation to take a strenuous day in the open air. He feels well all day, but goes to bed with a slight headache and may wake up the next morning with a severe one. On the other hand, similar headaches arise from excessive indoor work — overtime — especially if the worker stimulates himself to keep up his task with coffee, tea, alcohol, or tobacco. These drugs, of course, complicate the picture, as any one of them may cause headache with its own toxin. Another thing to be considered is the environment in which the person is working: Is the room stuffy? Is it noisy? Is the light trying to the eyes? In fact, are there any stimuli which in an ordinary eight-hour day would cause no symptoms, but which in excess may be important sensory irritants?

It is our experience that persons who have unstable vasomotor systems are the ones most affected in this way — *i. e.*, those individuals who blush and sweat easily, whose heart rate and blood pressure vary quickly, and who in addition show active pupillary and tendon reflexes. Rest invariably brings about relief, or a dose of "salts" may more quickly cure. These facts, taken with the observation that the face is usually flushed and the temporal artery conspicuously tortuous and tense during the attack, direct our attention to the vasomotor mechanism, and make us believe that cerebral congestion is the probable cause. The fact that the administration of a hypertonic solution in the form of a dose of salts gives quick relief corroborates this theory, because it is known that such solutions quickly reduce intracranial tension (5). This explanation seems more material than the one frequently given that "fatigue toxins" cause the headache, but it must be admitted that the physiological products of fatigue in the sensory nervous mechanisms and in the muscles may well initiate the vasomotor changes.

Closely allied to these common but mild headaches is *migraine*. This, unlike many headaches, is not merely a symptom, but seems to be a clearly defined disease entity characterized by periodic paroxysmal attacks accompanied by nausea or vomiting. The disease is strongly inherited, 90 per cent. of the cases showing antecedents or descendants with the same trouble (6). The onset is almost invariably during childhood or youth. Less important symptoms are the unilateral distribution of the pain in about two-thirds of the cases, and the ocular prodromal phenomena in about one-fourth. At present there is no accepted explanation of the symptoms, but the most satisfactory theory seems to be that vasomotor changes cause an increase in the bulk of the cranial contents, thus putting painful tension on the dura.

Three other common causes of headache should be given special mention. In the first place, *syphilis* must be thought of in

cases where the pain is chronic, and a Wassermann test should always be made on the blood; even if this test proves negative a lumbar puncture and examination of the spinal fluid is advisable whenever the case is difficult to diagnose. Secondly, *brain tumor* is much more common than is generally supposed and severe headache may be the first symptom, vomiting, choked disc and neurological signs appearing later. The third is *rheumatic headache*, also called "indurative" or "nodular." This type has been well described by Patrick (7) and Auerbach (8). The cardinal features are persistent headache with fluctuations, usually in people over 40 years of age, and primarily located in the suboccipital region but radiating to the neck, shoulders, and vertex. Changes in the weather often increase the pain. Palpation of the scalp reveals small tender nodules, and in the muscles of the neck indurated areas may be felt. During an exacerbation, however, the neck muscles are so spastic that nothing is palpable. General examination may reveal arthritis, low fever, leukocytosis and focal infection usually in the head. Massage and heat applied to the head and neck give relief — procedures which increase the pain in most other forms of headache.

It is not pertinent to continue enumerating the causes of headache, but having drawn attention to those types most frequently met with, we may summarize with the following table, modelled on Table 1 in Auerbach's book.

TABLE 4. — CLASSIFICATION OF THE DIFFERENT FORMS OF HEADACHE

*A. The More Independent Forms of Headache*

1. Migraine
2. Fatigue headache
3. Rheumatic headache

*B. Headaches Associated with Diseases of Individual Organs*

1. Brain disease (meningitis, encephalitis, tumor)
2. Organs of special sense (eyestrain, otitis)
3. Digestive tract (constipation, hunger, gastric hyperacidity, jaundice)
4. Kidney (nephritis)
5. Vascular (congestion from tight lacing, tight collars, lumbar puncture, sunstroke or menstruation; hypertension; arteriosclerosis)

*C. Headache in General Diseases*

1. Acute infections
2. Chronic infections (syphilis, paresis, rheumatism)
3. Intoxications (alcohol, lead, tobacco, ether, carbon monoxide, sulphuretted hydrogen, opium, iodoform, iodides)
4. Constitutional diseases (anemia, diabetes, endocrine disorders)

*D. Psychoneurotic*

*E. Combinations of Different Forms*

From the foregoing discussion it is apparent that the diagnosis of headache is far from simple; the examination of the patient must, therefore, be painstaking and prolonged. It would be impossible to outline a reasonably complete examination to cover all cases, but a brief account of what should be done in *every* case can be sketched, leaving to the discretion of the examiner the "leads" which are worth while following up by special examinations as indications may arise.

In the first place, a careful history must be taken, especially in regard to inheritance, exact occupation, home conditions and past illnesses. The importance of looking into the home conditions, such as family and marital relations, financial worries, etc., cannot be over-emphasized, since the group of psychoneurotic headaches depends largely on these factors; and psychoneurosis is one of the most frequent causes of the symptom. The history of the present illness should be taken in detail in order to obtain the facts concerning onset, duration, periodicity, and precipitating causes.

Next, the physical examination is taken up, and the organism studied in a thorough routine way, with special interest in a neurological examination which should include:

1. Cranial nerves, with ophthalmoscopic inspection of the fundus

2. Motor system, with inspection of muscular strength, gait, co-ordination and tremor
3. Reflexes, especially the knee jerks, ankle jerks and abdominals
4. Sensory system — which can usually be judged of by asking about subjective sensation, with quick tests of the cornea, pharynx and Romberg's sign
5. Sympathetic system — heart rate and pupillary reflexes to light and accommodation, with inspection of the skin for flushing and sweating
6. Endocrine system — thyroid, sex glands, skeleton, skin texture, and hair distribution
7. Temperature
8. Urine analysis

With a brief outline of this sort posted on the office wall, it adds remarkably little to the time of examination to note the positive findings, and in writing up the examination afterwards it is a great aid to have a list to remind one of omissions. The special examinations which will be found of most value are the Wassermann test; lumbar puncture; ophthalmological examination with special reference to visual fields; blood counts of red and white cells; X-ray of the skull, teeth and sinuses; transillumination; and stool examination. These procedures should be advised freely on the slightest indication, for the diagnosis is difficult at best and success often comes from unexpected sources.

## Summary

Headache is a common complaint among industrial workers, causing in some units as much as 23 per cent. of the cases of lost time, and an average of 10 to 15 per cent. in the mercantile establishments studied by us. The causes of headache are many, but among the employees whom we examined acute infection, constipation, poor hygiene, psychoneurosis, and eyestrain, in the order named, were the commonest. A careful history with interest in personal and occupational problems is essential to diagnosis. The physical examination must be thorough and orderly, with emphasis on neurological findings, but it need not be time-consuming if carried out according to schedule.

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# MEDICAL SUPERVISION IN INDUSTRY *

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### Millions Sacrificed in Lost Time

An educational campaign is now being carried on to bring home to the large manufacturing employers the value of medical supervision in industry.

The loss to British industry through diminished effort due to indifferent health or actual illness is calculated at something like £2,000,000 a week. It is difficult to credit such a stupendous figure, but that, I am assured, is the Industrial Welfare Society's estimate of the fluctuation of labour thus involved.

Dr. E. L. Collis, late Director of Welfare and Health to the Ministry of Munitions, is not, however, dismayed by this figure, for he declares that by proper medical supervision it could be reduced by 70 per cent. — *Evening Standard, London, June 25, 1921.*

THE above paragraphs are of great interest and importance at the present time when the proportion of the physically fit of the male population has been reduced to a lower point than at any previous period by the ravages of the Great War. We are accustomed to think of the law of "conservation of energy" in its narrow physical sense, but in human life there is also the possibility of the conservation of energy in industry. In the present world-crisis it behooves us to do our utmost to prevent waste in all directions and especially in the direction of conservation of human life, in which too little has been done in the past.

Although the British government, working through the local authorities, has done much to promote the effective treatment of known cases of tuberculosis, no organized effort has been made to prevent persons in the early stages of tuberculosis, of heart disease, and of epilepsy from entering industrial life, and, in the case of tuberculous patients, to prevent them from infecting their fellow-workers. The system of medical supervision described in this communication has been in use for twenty-one years and has been adopted by a number of large employers of labor. It has the advantage of being easily carried out, and by careful examination of all candidates for factory employment many early cases of disease may be detected and dealt with before irremediable damage has been done to a growing boy or girl, placed in an unsuitable environment.

It has been objected that, by the application of what may be termed "recruiting methods" to candidates for employment in large factories, those who are rejected will be driven to seek employment in other smaller factories or workshops where conditions are worse. This argument would apply equally to all attempts to improve the hygienic condition of the industrial classes. For example, it may be argued that because the hygienic standards of large cities have not been enforced hitherto by the health authorities of smaller urban districts and rural areas, these standards should be lowered; or, to take another example, because the Overseas Dominions and the United States insist rightly upon a rigorous medical examination of all immigrants in order to protect their populations from the undesirables of Europe, that these barriers should be lowered lest the undesirable and the unfit be driven back to their place of birth.

In the present day, when the Great War has caused the death or disablement of several millions of the most robust of the male population, the paramount importance of conserving the health of the remaining workers by protecting them from infection and by finding suitable employment for

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those who show signs of disease which will incapacitate them for factory life in a few years, will readily be admitted.

The examination of the greater part of the male population of Great Britain between the ages of 18 and 41 by medical recruiting boards during the Great War revealed a large amount of disease and of physical defects among the industrial classes. Dr. Carey Coombs has recently stated * that "examination of the war office records shows that 10 per cent. of the total rejections were for 'V. D. H.'" The Prime Minister, in characteristically picturesque language, said a few months ago, "You cannot run an A I empire with a C III population." Although school medical officers and school clinics have done much to improve the physique of children in the public elementary schools, no such supervision is exercised generally after these children leave school and enter industrial life. If they choose factory employment, they are examined prior to entry by the certifying factory surgeon, and if he passes them as fit for employment they may have no further medical examination except on applying to a panel-doctor for admission to his panel. The choice of employment is usually left to the individual boy or girl, guided more or less by their parents, and, as Dr. Carey Coombs observes, there has been no concerted attempt to find suitable employment for patients who have suffered from rheumatism or from tuberculosis during school life. Many of these patients who have reached adolescence enter factories and may work for a few years before they finally break down.

There is no system in general use by which employers, managers, and heads of workshops can be interested in the detection of active or latent disease among their employees. The system about to be described was introduced in 1900 in some large cocoa and chocolate factories in which over 4,000 persons of both sexes are employed. All candidates for employment are examined, as for life assurance, in regard to the condition of their teeth, hair, eyes, tonsils, heart, lungs and vaccination. Any defects are noted on an index card and the applicant is referred for treatment to his doctor or sent to a hospital. In the case of a girl, the mother attends with the superintendent, and the importance of treatment of any defects, such as carious teeth, defective sight, or very enlarged tonsils, is pointed out. It has been found that over 60 per cent. of girls coming from public elementary schools have the nits of *pediculus capitis* in their hair, and in these cases the mother is instructed in the method of removing them. If the parents are willing to have necessary treatment carried out, the boy or girl is re-examined after this has been done, but in case of refusal to undergo treatment, the applicant is rejected. All persons with serious heart disease or tuberculosis are consistently rejected.

In addition to this system of medical examination, the forewomen or superintendents are instructed to bring any girl to the medical officer for examination, if they think she is out of health. To this end, periodical short lectures on infectious diseases, and particularly on tuberculosis, are given to the heads of departments and workrooms. If an employee develops symptoms of tuberculosis he is suspended (at full wages) pending admission to a sanatorium or hospital, and on discharge from the institution patients are assisted to obtain suitable outdoor employment, but unless there is evidence of complete arrest of the disease after repeated examinations, and unless tubercle bacilli have disappeared from the sputum, they are not permitted to return to the factories.

The adoption of this system of preliminary medical examination and subsequent supervision reduced the annual death rate

* Coombs, C.: British Medical Association Branch Meeting, Bristol, March 31, 1921.

among over 2,000 women and girls from 6 per cent. to less than 1 per cent., and during several years no deaths from any cause occurred. Prior to the adoption of medical examination and supervision, four or five employees died annually from tuberculosis, and before they became too ill to work these patients had inevitably infected others in their workrooms as well as in their own homes.

On March 23, 1921, the Minister of Health stated in the House of Commons that the deaths from all forms of tuberculosis during the last six years (1915–1920, inclusive) reached a total of 311,017 — *i. e.*, an average annual death rate of 14.58 per *mille*. In other words, the deaths from all forms of tuberculosis during these six years amounted to 141.88 per *diem*, and if these patients had been collected in one center a population approximating that of Bath would have disappeared every year.

Dr. Addison observed that the figures for the last two years (46,312 deaths in 1919, and 42,505 deaths in 1920) were "the most encouraging since the inception of the scheme for the treatment of tuberculosis." It must, however, be remembered that, owing to the war and the subsequent wave of commercial prosperity, wages were high and unemployment had almost disappeared. Past experience shows that all great wars have been followed by commercial depression, with an inevitable increase in unemployment and its concomitants, underfeeding, underclothing, and overcrowding in ill-ventilated dwellings. There is reason to fear, therefore, that the annual death rate from tuberculosis will quickly reach, if it does not actually exceed, the pre-war figure, unless steps are taken speedily to deal more effectively with tuberculous patients among the industrial classes.

It must be admitted that, in spite of all that has been done during the last thirty years, the annual death rate from tuberculosis is a reproach to civilization. Under present conditions the majority of tuberculous patients are permitted to be employed in factories and offices until too ill to work. When they seek treatment it is found usually that the disease has reached so advanced a stage that there is no hope of cure, while at the same time they have frequently infected other members of their families and their fellow-workers. The following histories illustrate this point:

Case 1. — Harry P——, aged 54, was chief clerk to a firm of engineers. His youngest child (aged 12) died of tuberculous meningitis in 1906. Although there was a history of tuberculosis on both sides, neither he nor his wife nor their two surviving children showed any signs of the disease. In 1910, a clerk working opposite him died of pulmonary tuberculosis after a short illness. Although suffering from a severe cough with profuse expectoration, he was permitted to work until within a few weeks of his death. In 1912, H. P. developed an extensive infiltration of the upper lobe of the right lung with pleurisy at the right base. He was sent to a sanatorium in the Cotswolds for several months, and was then pensioned by his employers. A few months ago he was reported to be in good health.

Case 2. — Wilfrid S——, aged 26, was a clerk in one of the largest stores in London. When seen, he had returned to his home in Bristol in the last stage of pulmonary tuberculosis. He stated that three of his fellow-clerks working in one office had died of the same disease within two years.

Case 3. — Rose W——, aged 17, worked in a chocolate factory. She had been examined on leaving school two years earlier and remained in good health until six weeks before she was brought to the medical officer by her mother. She had extensive infiltration of the apices of both lungs with typical sputum containing numerous bacilli of bovine type. Her mother, who was very distressed, stated that her father had died recently after being an inpatient at the Bristol General Hospital under Dr. George Parker, to whom the writer is indebted for the particulars of his patient's last illness.

The father was a butcher employed at Avonmouth Docks. He came to the hospital with a diffuse cellulitis of the palm of the left hand, giving a history of having scratched himself when cutting up an ox. The hand was freely incised but the cellulitis did not subside, and a section of tissue showed giant cells with numerous tubercle bacilli of bovine type. He

quickly developed signs of massive infiltration of both lungs and was discharged as incurable. Before he could be sent to a sanatorium he committed suicide, when delirious, by jumping from his bedroom window.

Rose W—— died within three months of the onset of the disease, and, to complete this tragic family history, her brother (aged 14) died from tuberculous meningitis in the Bristol Royal Infirmary in 1913. The only satisfactory point in this case was that although Rose W——'s illness proved fatal, she was sent home before any of the other persons in the room in which she worked became infected. The forewoman was instructed to bring anyone who showed suspicious symptoms for immediate examination, but no other case occurred.

Although the detection and segregation of tuberculous patients has been emphasized on account of the wide distribution and serious results of tuberculosis among the population at large, it is obvious that a system which has proved successful in reducing the death rate from tuberculosis in a factory population of over 4,000 to less than 1 per *mille* per *annum* will be also applicable to the detection of cases of heart disease, epilepsy and other diseases, which, while affecting seriously the health and earning capacity of the person himself, are not direct sources of danger to his fellow-workers. The method is capable of wide application and development. For example, one company, employing over 10,000 workpeople, has adopted this system and insists on all "recruits" being vaccinated before commencing work in their factories and requires, in addition, that they sign an agreement to be revaccinated at any time that the company may require their workpeople to do so. Although it has been objected that this constitutes a technical "interference with the liberty of the subject," it has materially increased the percentage of the effectively vaccinated among the civil population of Bristol, and has thereby assisted the health department in preventing the spread of smallpox in several recent outbreaks which might have been serious among an imperfectly protected population.

In conclusion, it is satisfactory to learn that steps are now being taken by the British government to introduce a system of medical supervision in industry. Hitherto this matter has been left to the unaided efforts of a few far-seeing and enlightened employers, but it may be hoped that when the system is adopted on national lines those employers who have not hitherto realized the paramount importance of this subject will fall into line and aid the propaganda of the government.

# THE FRAMINGHAM HEALTH DEMONSTRATION AND INDUSTRIAL MEDICINE*

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THE industrial relationships and contacts of the Framingham Community Health and Tuberculosis Demonstration have been extremely important in the development of the Framingham tuberculosis program. These industrial factors constitute the chief consideration of this paper. Perhaps a preliminary word, however, with reference to the character of the demonstration in general may be helpful.

The Framingham experiment, or demonstration, has now been under way for nearly five years, under the auspices of the National Tuberculosis Association, financed by a special contribution of from \$150,000 to \$200,000 to this association from the Metropolitan Life Insurance Company. This demonstration has aimed to answer certain pertinent questions in the tuberculosis field, such as: How much tuberculosis is there? What is the best way to treat it? How best can a community be organized for the eventual control and elimination of the disease? Naturally, the demonstration has had an intense interest in industry, as it is in the industrial age group that the highest tuberculosis death rates are usually found. Certainly, tuberculosis is in part, at least, an industrial disease.

The chief activities of the demonstration were briefly:

1. A general and sanitary survey, including a survey of industrial hazards.

2. Extensive medical examination campaigns, covering a large fraction of all age groups, including industrial workers.

3. An expert consultation service for the diagnosis of tuberculosis, offered to private physicians, factory medical and nursing staffs, etc.

4. The thorough organization of the community itself, not only for tuberculosis control but for general health and disease preventive work, including the fields of general community sanitation, infant hygiene, school hygiene, and industrial hygiene.

Among the most important results of these activities, from the general as well as from the special industrial viewpoint, the following may be mentioned:

1. The examination of a representative population indicates that about 1 per cent. is suffering from active tuberculosis.

2. A thorough search for tuberculosis cases indicates that there are nine or ten active cases, in an average community, to every annual death from tuberculosis.

3. Adequate medical machinery in schools, factories, and elsewhere is essential to the detection of tuberculosis. A full-time physician for every 2,500 school-children or factory workers is essential. The first consistent medical examination work of the school population of Framingham (about 3,000) disclosed eleven cases of active tuberculosis and sixty-nine suspicious cases hitherto undetected. The establishment of adequate medical machinery in the factories increased the percentage of new cases annually discovered through factory medical machinery from 0 to 27 per cent. over a period of three years.

4. The average community does not report more than 55 per cent. of its active

* Read before the General Session on Health and Sanitation of the National Safety Council, Tenth Annual Safety Congress, Boston, Sept. 29, 1921. Received for publication Aug. 31, 1921.

tuberculosis in an early stage. Framingham experience has indicated that this percentage may be raised to 85.

5. The percentage of active tuberculosis cases receiving institutional care has been raised from 13 to 42 per cent.

6. The total health appropriations from both public and private sources have increased from 40 cents to about $2 per capita per year, the latter figure being set as an approximate standard for adequate community health work.

7. What will adequate machinery accomplish toward tuberculosis control and mortality reduction? Starting with a corrected tuberculosis mortality rate of 121 per hundred thousand as the average for the ten years preceding the demonstration, the rate fell to about one-half of that figure (64 per hundred thousand) in 1920, and present indications forecast a rate possibly in the neighborhood of one-fourth of the pre-demonstration rate for the current year (1921). This would indicate that the same measures, applied throughout the United States, would result in a saving of nearly 100,000 lives a year.

To return to the more important industrial considerations, it may be stated that there are in Framingham, at the outside, approximately 5,000 industrial workers. By far the largest industry, employing approximately one-half of this total, is a paper products plant where tags, boxes, and crepe paper articles are produced. Other industrial interests include carpet manufacturing, boiler construction, foundries, and the manufacture of shoes and automobile bodies.

The demonstration's approach to the solution of the tuberculosis problem has included two main efforts: first, a thorough survey of the industrial hazards of the community, carried out with the co-operation of the Massachusetts Board of Labor and Industry, the former New York Museum of Safety, and the New York State Commission on Ventilation, followed by an effort to correct the fundamental dangers to industrial workers; and second, an effort to encourage the local industries themselves, with necessary co-operation and aid at the start, to provide an adequate medical, nursing, clinic and dental service and personnel for the industrial employees.

On the side of personnel, when the work started there were employed by industries in the community one nurse and one part-time safety engineer. As a result of the co-operation which the industrial plants have given the demonstration during the past four years, it is now safe to say that between 70 and 80 per cent. of the industrial workers are under reasonably adequate medical, nursing and clinic supervision. The experience in the largest plant in the community, employing approximately 3,000 workers, is particularly illuminating from the point of view of employee interest in, enthusiasm for, loyalty to, and sympathy with the purpose and objectives of the medical and nursing program. This plant now employs a full-time physician and two nurses, and maintains an excellent clinic and first-aid establishment. The plant is organized on an advanced democratic profit-sharing and management-sharing basis, with considerable participation in control by employees of different grades, through industrial partnership, industrial associates, and shop committee devices.

This relationship between management and employees introduces certain novelties into the development of medical and nursing policies which might have seemed to a short-sighted view, in the beginning, to be obstacles, but which have, in reality, only the more firmly established the foundation for the program as a whole. Take, for instance, the matter of compulsory examination of new employees. It was not impossible to convince the management in this plant of the validity of the employment of

its medical and nursing machinery for this purpose. After the management was convinced, however, it was then necessary to convince the shop committee. Fortunately, the expert consultant of the health demonstration, Dr. P. C. Bartlett, has always worked in close co-operation with the members of the medical department in this plant, and, with their help, was able, by effective case histories of individuals ill with dangerous communicable diseases as found in this industry, to illustrate the importance of detecting such affections at the time of initial employment. The principle of compulsory examination was approved and was put through, with the backing of the management and of the men.

The members of the shop committee, employees in general, and the management, are now enthusiastic over the operation of this rule. It was not long after its application that the men themselves were asking: "If this is good for new employees, why isn't it good for all employees on a regular basis?" In fact, the next step has now been taken, and a system of regular periodic medical examinations for all employees, graded on the basis of age and period of employment, is now being experimented with.

Two or three other clinics with full-time nursing and part-time medical arrangements — in one instance with compulsory examination of new employees — have been developed in the community, and a plan promoted for the provision of a co-operative medical and nursing service for several of the smaller plants unable to provide full-time service for themselves. The actual establishment of this service is now dependent upon the more extensive revival of industrial activities.

While the Framingham experience has been on a relatively small scale, it has, nevertheless, been an intensive experience and may perhaps be legitimately used to suggest certain tentative standards for industrial medical work at large. It may even be possible to propose certain quantitative as well as qualitative standards. For instance, for an industrial unit of 2,500 people it would seem that there would be required at least one full-time physician and two full-time nurses, an adequate clinic equipment, some provision for dental service and at least part-time arrangements for safety. While the work of the medical and nursing staff may with advantage be organized as a fairly autonomous unit, it should, of course, be very closely related to certain other factory interests, such as the employment management service, the personnel division, the insurance or pension department, educational work, and welfare or recreation activities. Some of the functions of the medical and nursing staff would be:

1. The routine operation of the first-aid facilities and clinic, including the care for minor injuries and ills.

2. The diagnosis of chronic affections, with their reference to outside physicians of the individual's own choosing for continued treatment.

3. General health education by means of literature, lectures, bulletins, etc.

4. General safety work, machine guarding, etc.

5. General plant sanitation, including such matters as ventilation, cleanliness, water supply, etc.

6. Special class instruction, as, for instance, for groups of girls working on special types of machines, for whom group teaching in personal hygiene may be provided, covering such matters as posture, diet, clothing, and recreation.

7. Particular medical advice with reference to working and living adjustments for department heads and more responsible employees in the managerial class — a sort of local, intensified life extension service.

8. The regular examination of all new

employees, in co-operation with the employment department.

9. The regular periodic re-examination of permanent employees.

As previously indicated, it is our belief that medical and nursing facilities in industry can only be used to their full advantage if they are developed and operated in close co-operation with the labor groups concerned. These facilities must be used with a primary object of fitting the man to the job, and not as a device for the rigid elimination of the unfit from industry. It must be recognized by all that through the adaptation or, possibly, the elimination of a few will come the protection of many. It is probably unnecessary to say that such medical and nursing provision is a legitimate routine charge upon the industry, is, indeed, a thoroughly profitable investment, and should not be considered at all as a philanthropy which the employer provides for his employees.

Properly organized and promoted, an adequate medical and nursing service in industry will substantially decrease loss to the industry as a result of illness prevented, labor turnover reduced, etc. If the industry is intelligently organized on the basis of purposeful service, with the rational fundamental distribution of authority and responsibility, and with the necessary concomitant participation of workers in control, the medical service will be as useful as any other single device for enhancing the loyalty and devotional morale of the entire industrial group concerned. Adequate industrial medicine is an integral part of any decent physical foundation for a righteous industrial democracy.

# STUDY OF ACCIDENT RECORDS IN A TEXTILE MILL*

PREPARED UNDER THE DIRECTION OF

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BY

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UNTIL about thirty years ago, industrial accidents were regarded as a part of the day's work, and, as such, were looked upon as largely inevitable. With the growth of the workmen's compensation laws in the various countries and states, a new mass of material on industrial accidents has been culled from the records which the states required to be kept. Through the study of this material the waste of accidents has been made apparent and the safeguarding of life and limb has become an industrial issue. In the words of Miss Ida M. Tarbell, accident prevention has become a "gospel which, defended as a sound economic policy, is practiced with the whole-heartedness and zeal of a religion."

The development of the idea of prevention of accidents through a study of records in which the underlying causes might be discovered followed the appreciation of the magnitude of the waste. Accidents are expensive. They mean loss of time, idle machinery, and retarded production to the employer, as well as time out of work, suffering, and hardship to the employee. The prevention of accidents has become a matter of national interest as is evidenced by the organization of the National Safety Council, the program of which is devoted to the stimulating of interest in industrial safety work, and by the fact that several states and many of the leading cities of the country have inaugurated campaigns along the same line.

In 1884, Germany adopted a comprehensive system of accident compensation on a national scale. Since it was the first country to adopt such a system, and one of the first to require the reporting of hours of incidence of accidents, it now furnishes the most valuable and complete statistics of industrial accidents. The Imperial Offices in 1887, 1897, and 1907 published valuable reports of specific studies of industrial accidents. The United States has been much slower in the investigation of industrial accidents. Among the earliest reports in the field is one published by the Wisconsin Bureau of Labor in 1909–1910, giving a brief table of accidents distributed according to the hours of occurrence. To-day records of accidents are kept by practically all large establishments, but they vary widely in the fullness and care with which the information is entered. Examples of companies foremost from the point of view of the accuracy and care with which records are made are the International Harvester Company, Cheney Brothers, and the General Electric Company.

## Scope of the Study

The material for the present study was obtained from the records of the Cheney Brothers Silk Mills in South Manchester, Connecticut. This company is deeply interested in preventive measures, and regards accident expense as a part of the cost of production. It has a comprehensive system of recording accidents, and requires reports made of every accident, no matter how slight.

The study covers 1,221 accidents which occurred during the year 1920. This year

* Received for publication June 11, 1921.

was considered to be fairly representative, and the fact that the numbers employed by the company suffered no marked decrease shows a contrast to the general depression which was reflected in many other establishments as the year progressed. The data were transcribed from the company's records to the schedule shown in Figure 1. The information, except that concerning age, marital condition, and number of children, was obtained from the original records made at the time of the occurrence of the accident. The data for the additional items were transcribed from the records of the employment bureau. The number of *persons* injured appears in the summaries as smaller than the number of *accidents* — a fact which should be kept in mind in studying the tables which follow. The scope of the study did not permit obtaining records of number of man-hours and the total number of days worked for all of the employees, and consequently it was not possible to present accident rates according to the method advocated by former Commissioner of Labor Statistics Meeker.* The number of accidents is therefore related simply to the numbers employed on the date specified.

FIGURE 1

ACCIDENT REPORT — CHENEY BROS.

NAME ..... AGE .... MARRIED / SINGLE NO. OF DEPENDENT CHILDREN UNDER 16

OCCUPATION

DATE HOUR DAY MONTH YEAR

NATURE AND EXTENT

CAUSE

SURGICAL AID TIME WITH CO.

ACCIDENT DUE TO

- CARELESSNESS OF INJURED PERSON
- HAZARD OF TRADE
- CARELESSNESS OF FELLOW-WORKMEN
- DEFECT IN MACHINERY, TOOLS OR PREMISES

DURING NECESSARY PERFORMANCE OF WORK

UNDERSTANDS ENG. TOTAL EXPENSE

## CHARACTER OF ACCIDENTS

It is clear that the manufacture of silk does not necessarily carry a hazard of serious accident. For the most part, the accidents listed in Table 1 were of minor importance. The majority were slight cuts, abrasions, and bruises; the more serious accidents, such as scalp wounds and fractures, occurred more rarely. The contrast in the percentage of men and women workers who suffered from the various accidents is largely attributable to the different occupations requiring the use of different tools. In 1921 there were 2,891 men employed in the manufacturing operations in this factory, of whom 30.0 per cent. were injured, and 1,819 women, of whom only 19.4 per cent. were injured. The higher percentage of accidents to men is probably largely due to the fact that in silk

* This method is described in the Bulletin of the United States Bureau of Labor Statistics, Whole Number 234, 1918, pp. 52–66.

manufacture, as in most other industries, men are employed in more hazardous occupations than women.

The minor character of the accidents is shown in another way in Table 2, which gives the amount of time lost through accident. There were only ninety-six cases reported in which any time was lost, and fifty-seven of these incapacitated the worker for less than two weeks. In 945 cases, or 77.4 per cent. of the total, there was no loss of time. The majority of accidents studied were of minor importance from a financial standpoint as well as from the point of view of the amount of time lost (Table 3). In the case of nearly one-half (581) of the whole number of accidents, no financial outlay or compensation was reported. More than one-third (38.9 per cent.) of the 640 involving expense amounted to less than $5, and nearly two-thirds (65.6 per cent.) to less than $10. The case which resulted in the maximum expense ($807.58) was a compensation case following the amputation of an index finger injured by a picker stick.

Table 4 indicates that more than three-fourths (79.5 per cent.) of all the accidents which occurred in the mill were injuries to the hands (including fingers and thumbs) and arms. This obviously results from the greater exposure of these members in operating the tools and machines. When one considers that the weaver's hands may at any moment come in contact with the knife of the loom and the picker stick, that agility is required of a doffer to keep from injuring his hands in changing the bobbins, and that many times a day a knife must be used to clean the silk waste from a bobbin, it is not surprising that the hands and arms bear the brunt of the injuries. The number of accidents to the eyes is large, but is explained by the fact that even a tiny particle of dust lodging there was reported as an accident, though

TABLE 1. — NATURE OF ACCIDENTS

| Nature of Accidents | Number of Accidents | | | | | |
|---|---|---|---|---|---|---|
| | Total | | To Men | | To Women | |
| | Number | Per Cent | Number | Per Cent. | Number | Per Cent. |
| Total | 1,221 | 100.0 | 868 | 100.0 | 353 | 100.0 |
| Cuts | 238 | 19.5 | 152 | 17.5 | 86 | 24.4 |
| Lacerations | 196 | 16.1 | 155 | 17.8 | 41 | 11.6 |
| Abrasions | 175 | 14.3 | 104 | 12.0 | 71 | 20.1 |
| Bruises and abrasions or lacerations | 138 | 11.3 | 103 | 11.9 | 35 | 9.9 |
| Incisions | 91 | 7.5 | 61 | 7.0 | 30 | 8.5 |
| Strains and sprains | 77 | 6.3 | 59 | 6.8 | 18 | 5.1 |
| Foreign bodies in eyes | 63 | 5.2 | 57 | 6.6 | 6 | 1.7 |
| Punctures | 62 | 5.1 | 41 | 4.7 | 21 | 5.9 |
| Splinters and slivers | 35 | 2.9 | 26 | 3.0 | 9 | 2.6 |
| Burns | 25 | 2.0 | 23 | 2.6 | 2 | 0.6 |
| Infections | 21 | 1.7 | 7 | 0.8 | 14 | 4.0 |
| Scratches | 10 | 0.8 | 8 | 0.9 | 2 | 0.6 |
| Fractures | 10 | 0.8 | 10 | 1.2 | | |
| Blisters | 7 | 0.6 | 4 | 0.5 | 3 | 0.9 |
| Swellings | 7 | 0.6 | 6 | 0.7 | 1 | 0.2 |
| Inflammations | 6 | 0.5 | 6 | 0.7 | | |
| Scalp wounds | 5 | 0.4 | 5 | 0.6 | | |
| Abscesses | 4 | 0.3 | 4 | 0.5 | | |
| Hernia | 3 | 0.2 | 3 | 0.3 | | |
| Miscellaneous | 48 | 3.9 | 34 | 3.9 | 14 | 3.9 |

TABLE 2.—LENGTH OF TIME LOST BECAUSE OF ACCIDENTS

| Time Lost | Number of Accidents |
|---|---|
| Total | 1,221 |
| No time lost | 945 |
| Less than 1 week | 29 |
| Less than 1 day | 2 |
| 1 day | 4 |
| 2 days | 7 |
| 3 days | 7 |
| 4 days | 2 |
| 5 days | 6 |
| 6 days | 1 |
| 1 week and less than 2 | 28 |
| 2 " " " " 3 | 9 |
| 3 " " " " 4 | 9 |
| 4 " " " " 5 | 4 |
| 5 " " " " 6 | 3 |
| 6 " " " " 7 | 4 |
| 7 " " " " 8 | 3 |
| 8 " " " " 9 | 0 |
| 9 " " " " 10 | 2 |
| 10 " " " " 11 | 0 |
| 11 " " " " 12 | 1 |
| 12 " " " " 13 | 1 |
| 13 " " " " 14 | 0 |
| 14 " " " " 15 | 1 |
| 15 " " " " 16 | 0 |
| 16 " " " " 17 | 0 |
| 17 " " " " 18 | 1 |
| 18 " " " " 19 | 0 |
| 19 " " " " 20 | 1 |
| Not reported | 180 |

it may have occasioned discomfort for a few moments only.

## Cause and Responsibility

A large proportion of the accidents occurred in connection with the use of machinery, a fact which is a natural consequence of the extensive employment of machinery in textile industries. More than one-third (36.0 per cent.) of the accidents were so classified (Table 5). Hand tools, including such instruments as knives, scissors and hooks, were responsible for one-fifth of the whole number, but it should be remembered that the majority

TABLE 3.—EXPENSE OF ACCIDENTS

| Expense in Dollars | Accidents | |
|---|---|---|
| | Number | Per Cent. |
| Total | 640 | 100.0 |
| 1 and less than 5 | 249 | 38.9 |
| 5 " " " 10 | 171 | 26.7 |
| 10 " " " 15 | 75 | 11.7 |
| 15 " " " 20 | 40 | 6.3 |
| 20 " " " 25 | 20 | 3.1 |
| 25 " " " 30 | 17 | 2.6 |
| 30 " " " 35 | 7 | 1.1 |
| 35 " " " 40 | 12 | 1.9 |
| 40 " " " 45 | 4 | 0.6 |
| 45 " " " 50 | 5 | 0.8 |
| 50 and over | 40 | 6.3 |

of these were slight injuries. This is also true of the remainder of the accidents, many of which were not hazards peculiar to the manufacture of silk.

In Table 6 the accidents are shown classified as they were reported in the factory record according to the responsibility for their occurrence. Two-thirds of the accidents (67.1 per cent.) were attributed to *hazard of trade*, and include such accidents as injuries to the hands incurred while putting belts on rollers, cutting the hands when working with reed wires, or contact with moving bobbins. *The carelessness of*

TABLE 4.—PART OF BODY INJURED

| Location of Injury | Injuries | |
|---|---|---|
| | Number | Per Cent. |
| Total | 1,221 | 100.0 |
| Hands | 834 | 68.3 |
| Fingers | 451 | 36.9 |
| Thumbs | 210 | 17.2 |
| Palms and backs | 173 | 14.2 |
| Arms | 136 | 11.2 |
| Head and face | 126 | 10.3 |
| Eyes | 71 | 5.8 |
| Other | 55 | 4.5 |
| Feet | 38 | 3.1 |
| Torso | 32 | 2.6 |
| Legs | 31 | 2.5 |
| Shoulders | 15 | 1.2 |
| Miscellaneous | 9 | 0.8 |

*the injured person* was the source of a second large group (24.7 per cent.). In order to show the full extent of individual responsibility as a factor, there must be added to the above the cases caused by the carelessness of the fellow-worker and the cases in which carelessness, together with defective machinery, was responsible, making a total of 335 cases, or 27.5 per cent. There is often disagreement as to whether carelessness has actually been shown. In the above case the judgment taken was that of the foreman reporting at the time of the accident. The large number of accidents due to these causes indicates roughly the extent to which the accidents might be prevented by the education of the worker in the importance of safety methods.

TABLE 5. — CAUSES OF ACCIDENTS

| Cause | Number | Per Cent. |
|---|---|---|
| Total Accidents | 1,221 | 100.0 |
| Machinery | 440 | 36.0 |
| Tools | 244 | 20.0 |
| Falling, tripping, and slipping | 86 | 7.1 |
| Slivers, nails, tin, etc. | 72 | 5.9 |
| Lifting and moving | 68 | 5.6 |
| Flying particles | 64 | 5.3 |
| Rolling and falling bodies | 59 | 4.8 |
| Collisions with stationary bodies | 36 | 2.9 |
| Materials | 28 | 2.3 |
| Liquids | 20 | 1.6 |
| Glass | 16 | 1.3 |
| Miscellaneous | 72 | 5.9 |
| Not reported | 16 | 1.3 |

## Time of Occurrence

Practically all studies of accidents have shown a marked clustering in the latter part of the morning and afternoon periods. In the accidents grouped according to hour of occurrence, in Table 7 and Figure 2, peaks occurred between 10 and 11 o'clock in the morning, and between 3 and 4 in the afternoon. Similar peaks have usually been attributed to the fatigue of the worker which brings with it increased hazard in the worker's failing alertness. In the present instance, an explanation, which has not been hitherto emphasized in the literature of fatigue, was suggested by an official of the company and commended itself to the writers as an extremely reasonable one. He said:

> The facts are that the foremen are so rushed with supervisory duties in the early hours of the morning and afternoon, and the employees are so bent upon getting their work started and well in hand, that the minor accidents, which constitute a very large proportion of the whole, do not get attention until the breathing spell comes, about half past ten and half past three.

In the last hours of both periods fewer accidents occurred. A similar recovery has been noted in other accident studies and is attributed by Miss Josephine Goldmark * to the decreased number at work during the last hours and to the fact that the worker, having reached a high point of fatigue, unconsciously slows down in the last hour and in this way decreases the risk. Anticipation of the coming rest period has also been suggested as a cause of decrease in the number of accidents

TABLE 6. — RESPONSIBILITY FOR ACCIDENTS

| Responsibility for Accidents | Number of Accidents | Per Cent. |
|---|---|---|
| Total | 1,221 | 100.0 |
| Hazard of trade | 820 | 67.1 |
| Carelessness of injured person | 301 | 24.7 |
| Defect in machinery | 35 | 2.9 |
| Carelessness of fellow-workman | 25 | 2.1 |
| Defect in premises | 11 | 0.9 |
| Carelessness of injured person and defect in machinery, tools, or premises | 5 | 0.4 |
| Carelessness of injured person and of fellow-workman | 4 | 0.3 |
| Defect in tools | 3 | 0.2 |
| Not reported | 17 | 1.4 |

* Goldmark, J.: Fatigue and Efficiency. New York, Russell Sage Foundation, 1912, pp. 77, 78.

during the last hour of work. Conversely, the large number of accidents at the peak hours has been attributed to the fact that as the work progresses the employee becomes more accustomed to it and works at a higher speed, and when this high speed is attained, the increased repetition of an act gives increased opportunity for accident. A slightly different point of view was held at the Cheney Mill, where the rapid falling off toward noon and 4 o'clock was attributed to the unwillingness of the workers to take time off just before they were going home. This, and "not any psychological state of mind or condition of fatigue," was advanced as the cause of the character of the curves noted.

TABLE 7.—OCCURRENCE OF ACCIDENTS BY HOURS

| Hour | Accidents | |
|---|---|---|
| | Number | Per Cent. |
| Total | 1,221 | 100.0 |
| 7– 8 A.M. | 48 | 3.8 |
| 8– 9 | 102 | 8.4 |
| 9–10 | 134 | 11.0 |
| 10–11 | 154 | 12.6 |
| 11–12 | 113 | 9.3 |
| 12– 1 Lunch Hour | 15 | 1.2 |
| 1– 2 P.M. | 90 | 7.4 |
| 2– 3 | 123 | 10.1 |
| 3– 4 | 130 | 10.6 |
| 4– 5 | 107 | 8.8 |
| 5– 6 | 15 | 1.2 |
| 6 and after | 7 | 0.6 |
| Not reported | 183 | 15.0 |

The accident risk does not appear so great in the first and last hours of the morning and afternoon because it is usually not possible to make allowance in the first hour for the number who are late, and in the last hour for the employees who usually spend the last few minutes in getting ready to go home and who are, consequently, not exposed. The first hour of the afternoon has a higher percentage than the first hour of the morning, which may be partly due to the fact that the fatigue is then greater.

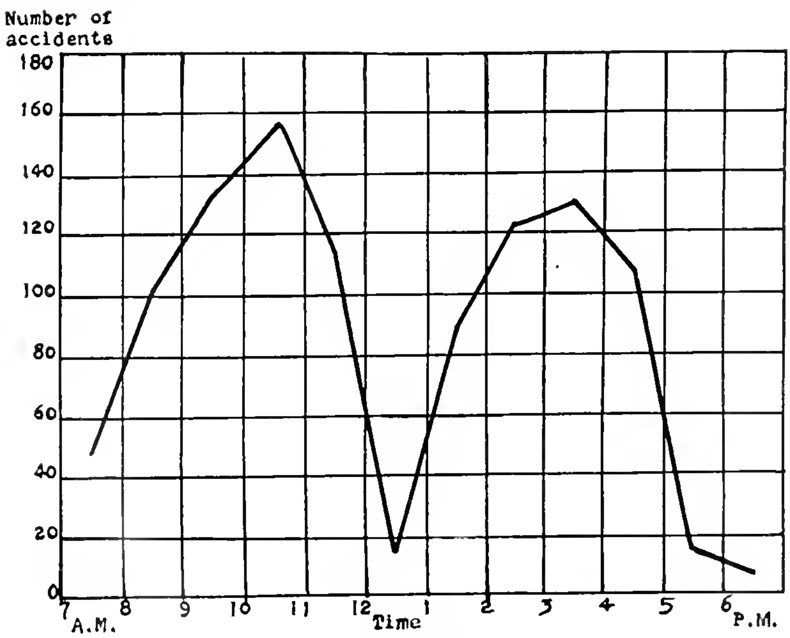

FIG. 2.—Occurrence of accidents by hours.

In a similar investigation* of accidents in textile mills covering the calendar years 1918 and 1919, the peak hours were found to be 9 in the morning and 3 in the afternoon. The author suggests that regularly recurring psychological and physiological cycles, such as mid-morning and mid-afternoon drowsiness as a consequence of eating, may also be important factors, as well as the increased risk with the higher speed following the low mental period.

A marked variation in the number of accidents on different days of the week is probably accounted for as much by out-

* Gates, D. S.: A Statistical Study of Accidents in the Cotton Mills, Print Works, and Worsted Mills of a Textile Company. JOUR. INDUST. HYG., 1920–1921, **2**, 287.

side factors causing fluctuation of the attention as by differing degrees of fatigue. In a study of the accidents in the Burroughs Adding Machine factory for the years 1919 and 1920, the disturbing effect of pay day is stressed.

In the year 1919 the factory day force was paid Saturday noon and the night force Friday evening; consequently, it is found that more accidents resulted on Fridays and Saturdays than on any other day of the week. In 1920, pay day was so arranged that certain sections of the factory were paid on different days of the week; a lowering of accidents per day was at once noticed.*

TABLE 8. — OCCURRENCE OF ACCIDENTS BY DAYS

| Days | Accidents | |
|---|---|---|
| | Number | Per Cent. |
| Total | 1,221 | 100.0 |
| Monday | 227 | 18.6 |
| Tuesday | 190 | 15.6 |
| Wednesday | 229 | 18.8 |
| Thursday | 194 | 15.9 |
| Friday | 226 | 18.5 |
| Saturday [1] | 106 | 8.7 |
| Sunday | 17 | 1.3 |
| Not reported | 32 | 2.6 |

[1] Saturday is a half-day.

In the present study, Monday, Wednesday and Friday stand out as days when more accidents occurred. (Table 8 and Figure 3.) The high percentage on Monday may be occasioned by the fact that it is difficult to settle down to the routine of work after the Saturday afternoon and Sunday break. Possibly the Wednesday peak is to be attributed to the facts that Tuesday is pay day and the stores in the town are open on Tuesday night. The sequence is repeated on Thursday and Friday. It is reasonable to assume that many of the workers go out on Thursday evenings since that is the night for the change of feature at the moving pictures. After Friday the drop in the Saturday accident rate is not so great as the drop from the high rates of Monday and Wednesday, when the fact that Saturday is only a half-day is allowed for. Saturday morning is a period of anticipation of Saturday afternoon good times; the worker's mind is occupied partly with plans for the afternoon and is not wholly devoted to his work. Another cause for the accumulation of accidents near the end of the week is probably the haste of the pieceworkers, in their attempt to catch up after "taking it easy" at the beginning of the week. In their haste they are liable to become careless and are subject to a greater accident

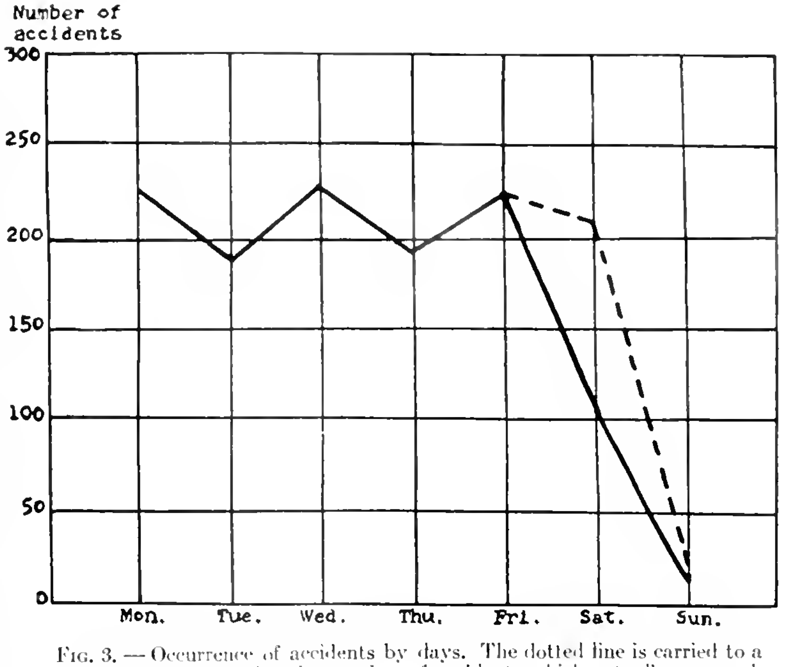


FIG. 3. — Occurrence of accidents by days. The dotted line is carried to a point which indicates twice the number of accidents which actually occurred, since Saturday is a half-holiday.

* State of Mind the Largest Contributor to Safety. Burroughs Magazine, April, 1921, p. 5.

risk. Added to these causes is the cumulative fatigue of the week's work.

## Age and Sex of Injured Person

The findings of this study show clearly that age is an important factor in the accident rate. The employees under 20 years of age met with a larger proportion of accidents than did those in any other age groups — a fact which supports the statements in the study of textile accidents made by Mr. Donald S. Gates, referred to above, to the effect that the younger employees (in the latter instance those 18 years of age) were subject to the greatest accident risk.

Table 9 and Figure 4 show the age distribution of the injured persons and the relationship of the number of injuries incurred by employees of the various age groups to the total numbers of those ages employed. It must be remembered that the accident figures used in this table refer to the *number of accidents*, and the fact that numbers of *individuals* suffered more than one injury is ignored in the table itself. The strikingly larger proportion of men than women among the injured, already noted, holds for almost every age group.

Table 9 shows not only the high accident rate for the younger employees, and especially the younger men, but also the significant fact that the decrease of risk with increasing age is to some extent regular, with the exception of the fact that the employees from 30 to 35 years fared better than their fellow-employees who were slightly older. The numbers of employees who were past middle age were so small that no attempt can be made to interpret the figures which pertain to them.

The peculiar susceptibility of young people to accidents is probably due to a combination of influences, of which inexperience and unfamiliarity with the work and the necessary precautions, carelessness and a form of bravado, lack of attention and concentration due to lack of training, as well as possible greater exposure to the objective dangers of their

TABLE 9. — ACCIDENT EXPOSURE BY AGE AND SEX

| Age of Injured | All Employees | | | Men | | | Women | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Accidents | | | Accidents | | | Accidents | |
| | Number [1] | Number | Rate per 100 Workers | Number | Number | Rate per 100 Workers | Number | Number | Rate per 100 Workers |
| Total | 4,710 | 1,221 | 25.9 | 2,891 | 868 | 30.0 | 1,819 | 353 | 19.4 |
| Less than 15 | 35 | 13 | 37.1 | 7 | 8 | 114.3 | 28 | 5 | 17.9 |
| 15 and less than 20 | 671 | 288 | 42.9 | 305 | 181 | 59.3 | 366 | 107 | 29.2 |
| 20 " " " 25 | 772 | 216 | 27.9 | 393 | 145 | 36.9 | 379 | 71 | 18.7 |
| 25 " " " 30 | 763 | 161 | 21.1 | 474 | 113 | 23.8 | 289 | 48 | 16.6 |
| 30 " " " 35 | 681 | 136 | 19.9 | 458 | 109 | 23.8 | 223 | 27 | 12.1 |
| 35 " " " 40 | 533 | 120 | 22.5 | 343 | 98 | 28.6 | 190 | 22 | 11.6 |
| 40 " " " 45 | 384 | 78 | 20.3 | 257 | 66 | 25.7 | 127 | 12 | 9.4 |
| 45 " " " 50 | 305 | 64 | 20.9 | 211 | 47 | 22.3 | 94 | 17 | 18.1 |
| 50 " " " 55 | 241 | 41 | 17.0 | 182 | 29 | 15.9 | 59 | 12 | 20.3 |
| 55 " " " 60 | 157 | 29 | 18.4 | 122 | 24 | 19.7 | 35 | 5 | 14.3 |
| 60 " " " 65 | 114 | 12 | 10.5 | 92 | 10 | 10.9 | 22 | 2 | 9.1 |
| 65 and over | 54 | 6 | 11.1 | 47 | 5 | 10.6 | 7 | 1 | 14.3 |
| Not reported | .. | 57 | .. | .. | 33 | .. | .. | 24 | .. |

[1] Number of persons employed January 1, 1920.

trades play a part. For the most part, the accidents to the younger persons were not disabling.

An examination of the individual records also showed that the young people tended to encounter more than one injury to a greater degree than did older persons. Approximately one-half (47.2 per cent.) of the 212 persons who had more than one accident were between 14 and 25 years old, though this group constituted less than one-third (31.4 per cent.) of the whole number of employees. The individual who had the maximum number of accidents during the year — eleven — was also a member of this younger group. The fact that the majority of the accidents were of small consequence prevented the experience from having much of the quality of a warning which would teach more caution next time.

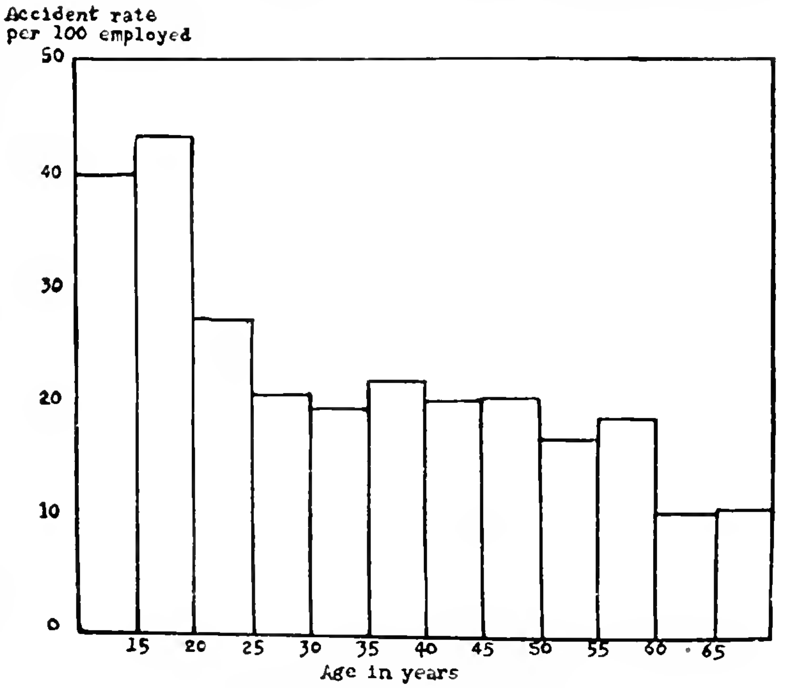

Fig. 1. — Accidents according to age.

The study offers evidence to prove that a careful system of reporting accidents and immediate care of injuries are effective factors in a program of accident prevention. There is little room for doubting that the practice of giving prompt attention to even the slightest injuries is one of the best reasons why so few accidents at the Cheney plant entailed serious consequences. It is safe to say that treatment of an insignificant cut has many times prevented serious infection.

Accident rates in many states have been reduced by laws compelling the guarding of machines, but the passing of state laws can do little to eliminate human carelessness. In the study of accidents made at the Burroughs Adding Machine factory it was contended that "state of mind" was the largest contributor to safety. Since evidence of carelessness is particularly marked in the workers under 20 at the Cheney plant, it becomes apparent that special attention should be directed to the younger workers and perhaps particularly to the young men in a campaign for the further prevention of industrial accidents.

## BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**Government Control and Operation of Industry in Great Britain and the United States During the World War.** By Charles Whiting Baker, C.E. Carnegie Endowment for International Peace. Preliminary Economic Studies of the War, No. 18. Edited by David Kinley, Professor of Political Economy, University of Illinois; Member of Committee of Research of the Endowment. Paper. Pp. 138 with index. New York: Oxford University Press, 1921.

**Government War Contracts.** By J. Franklin Crowell, Ph.D., LL.D. Carnegie Endowment for International Peace. Preliminary Economic Studies of the War, No. 25. Edited by David Kinley, Professor of Political Economy, University of Illinois; Member of Committee of Research of the Endowment. Paper. Pp. 357 with index. New York: Oxford University Press, 1920.

**The Control of Sex Infections.** By J. Bayard Clark, M.D., Fellow of the New York Academy of Medicine; Fellow of the American College of Surgeons; Member of American Urological Association; American Association Genito Urinary Surgeons; International Surgical Society; Sometime Major Medical Corps U. S. Army, etc. Cloth. First Edition. Pp. 132 without index. New York: The Macmillan Company, 1921.

**Nerves and the Man.** A Popular Psychological and Constructive Study of Nervous Breakdown. By W. Charles Loosmore, M.A., Brown Scholar at Glasgow University. Cloth. Pp. 223 with index. New York: George H. Doran Company, 1921.

**Epidemic Respiratory Disease.** The Pneumonias and Other Infections of the Respiratory Tract Accompanying Influenza and Measles. By Eugene L. Opie, M.D., Colonel, M.R.C., U. S. Army; Professor of Pathology, Washington University School of Medicine; and Francis G. Blake, M.D., Major, M.R.C., U. S. Army; Associate Member of the Rockefeller Institute for Medical Research; and James C. Small, M.D., Formerly First Lieutenant, M.C., U. S. Army; Bacteriologist, Philadelphia General Hospital; and Thomas M. Rivers, M.D., Formerly First Lieutenant, M.C., U. S. Army; Associate in Bacteriology, Johns Hopkins University. Cloth. First Edition. Pp. 402 with illustrations, index, and appendix. St. Louis: C. V. Mosby Company, 1921.

**Henley's Twentieth Century Formulas, Recipes and Processes.** Containing Ten Thousand Selected Household and Workshop Formulas, Recipes, Processes and Money Saving Methods for the Practical Use of Manufacturers, Mechanics, Housekeepers and Home Workers. Edited by Gardner D. Hiscox, M.E. Cloth. 1921 Edition, Revised and Enlarged. Pp. 807 with index. New York: The Norman W. Henley Publishing Company, 1921.

# THE JOURNAL OF INDUSTRIAL HYGIENE

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## WHEN ARE DISABILITIES OF THE BACK ARISING OUT OF PATHOLOGICAL CONDITIONS REPORTABLE ACCIDENTS?*

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OF all the problems that confront the industrial surgeon there is none more difficult to handle than the familiar "strained back." Osgood (1), in his article read before the meeting of industrial surgeons at Atlantic City in June, 1919, has shown a very proper conception of the perplexity of the situation, and his article represents as good a medical résumé of the subject as may be found.

Almost every day the industrial surgeon is consulted by a workman who says, "I believe I have strained my back." Broadly speaking, such cases fall into two groups, the first of which is composed of strains which date from a definite experience, such as a slip or a fall, or the lifting of some unusually heavy object. These cases usually conform to our conception of what is meant by an accident as set forth by the Workmen's Compensation Law of New York State. When a workman is able to point to a particular trauma at a certain time of the day, which is unusual and not a part of his routine work, there is no problem involved. The case is always reportable, provided there is loss of time or more than first-aid treatment. The second class, however, is far more numerous and difficult to handle. Cases in this group differ from those in the first in that they are referable to no definite time or unusual experience. The workman presents himself for an examination complaining of "lumbago" or "rheumatism," with or without some rise in temperature. His usual statement is, "Doc, I believe I have strained myself lifting boxes in Department X."

"When did it happen?"

"Two or three weeks ago, I can't say exactly when."

"Did anything unusual happen?"

"No, I was simply stooping over (or lifting some boxes) and felt no pain at the time."

"When did the pain develop?"

"It came on today."

Further questioning will generally reveal the fact that the workman was doing his regular work in a routine manner without the occurrence of a single incident which might be thought to be apart from the ordinary routine of his work. We have found that the onset in this particular type of case is not so dramatic as that in class one. The consequences, however, may be, and frequently are, quite as serious. It was

* Received for publication Sept. 1, 1921.

formerly our custom to report all of these cases as accidents. They have, however, become so serious and so numerous, and have shown such a large variety of etiological factors, when carefully studied, that we now hesitate before reporting them as accidents. Fortunately, under the existing state compensation law we are permitted ten days in which to report an accident, and it is during this time that we investigate through the workman's department the circumstances attending the disability and make a thorough medical examination of the case, including X-ray examination, Wassermann, and a thorough physical examination.

It is our opinion that of this latter type of case each has developed from some focus of infection. Only occasionally have we been unable to demonstrate such a focus. Certainly, nine cases out of ten are, in our opinion, not reportable accidents within the meaning of the workmen's compensation law. The most common causes in this group of cases have been thought to be faulty posture, infected teeth or tonsils, syphilis, tuberculosis, weak feet, etc. Indeed, it is really surprising to find the number of cases of chronic disease which are encountered, in which a workman feels that his condition is due to some slight injury, and it is in the handling of these chronic diseases that we are confronted with our most serious problems. Often the only complaint which a workman will have is a strained back, and upon thorough examination some other condition will be discovered. It is not uncommon to hear a workman say, "I have not been so well since I was hurt," when he is really suffering from advanced tuberculosis, syphilis, or some other chronic disease. A great many workmen are entirely unfamiliar with the workmen's compensation law and regard themselves as victims of an accident without any consideration of what is really wrong with them, or of the manner in which their disability has developed. The following three cases taken from a much larger group are illustrative of the points under discussion:

Case 1. — L. H., female, 37 years of age, and weighing 140 pounds, at 3 p.m. on April 6, 1918, in the course of her ordinary employment, reached to pick up from a basket placed on the floor a small object weighing about 2 ounces. This was a part of her routine work. On this particular occasion, she felt something slip in her back, became unable to move her right leg, and three or four days later became almost completely disabled. She did not slip or fall, and there appeared to be nothing unusual about the manner in which her disability developed. The case was reported as a right sacro-iliac strain, and the woman was referred to a specialist who applied a cast and, later, a brace. Her case dragged along for two years, during the greater part of which period she did not work. In her particular case, it seemed as though there was some malingering, inasmuch as she was often seen to walk in a perfectly normal manner, whereas, before the Industrial Commission, she would appear almost a complete invalid. A contest was raised, after two years, that an accident was never sustained. The Industrial Commission closed the case on the ground that there was no accident.

The interesting feature, which this case illustrates, is that an employee may develop a disabled condition of the back which is not a reportable accident and should not be reported as such.

Case 2. — E. M., male, 46 years of age, and weighing 186 pounds, on December 12, 1918, leaned forward in the course of his ordinary employment and lifted from one stall to another a jar of liquid weighing about 50 pounds. The vertical lift was 2 feet, and the horizontal, about 1½ feet. He had been performing this particular operation for many years, but on this particular occasion was seized with a terrific pain in the region of the right sacro-iliac joint, became incapacitated, and was taken home. There is no record, in this case, of the man's having slipped or fallen, or of his having been struck. He was apparently performing a routine operation in a routine way. His case was reported as a sacro-iliac strain. During the course of treatment by a specialist, he developed a phlegmasia alba dolens and, later, cystitis and varicose ulcers of the right leg. He has drawn compensation at intervals since the period of injury. While the final award has not been

made in this case, it is easy to see that the amount involved is very considerable, and it is difficult to understand how this can be called an accident even though it was so ruled by the Industrial Commission.

This case differs from that of L. H. in only one respect, namely, that the weights lifted were different. Nevertheless, very considerable compensation has been paid and the case is still on the calendar. It is not uncommon to have three or four such cases a month — cases in which there is a sudden seizure in the region of the sacro-iliac joints with disability for a short time. It is not often, however, that cases are as prolonged as was the case of E. M., but they are occasionally seen. The third case is somewhat different from the two which we have already described.

Case 3. — G. A., male, 36 years old, weighing 146 pounds, was reported to have sustained an accident at 4 p. m. on January 4, 1921 in the following manner. Previous to the accident he was transferred from inside machine work to the yard. The weather was rather severe and at this particular time there were high winds. On the day mentioned, while he, with three other men, was using a crowbar to roll a heavy pipe into place, he felt a sudden pain below the angle of the left scapula. He was pulling rather hard at the crowbar, but was not using his full strength nor working harder or in a more strained position than his assistants. On the following day he did not report for work, and on visiting his home we found that his temperature was 102°, and his pulse 106. He was perspiring profusely. His temperature gradually came down and in three weeks he came back to work. The only local physical sign was tenderness in the angle of the scapula. There was no redness and no swelling. Motion of the right arm was limited but only in so far as the scapular action was brought into play. It was evident that this was not altogether an accident, but just how much of the syndrome was accident and how much disease, is very difficult to say. The patient demanded a diagnosis, and when he was informed that it was "lumbago" he remarked, "Doc, I cannot collect on an accident policy for that." The case was reported as an accident and so carried by the Industrial Commission even though we felt that disease played perhaps the most prominent rôle.

In this case we have a disabled back due to an acute febrile condition. In all probability the strain was nothing more than a coincidence, yet this case was reported as an accident. During certain seasons of the year, mostly in the spring and autumn when there are frequent changes in the weather, we have "crops" of cases similar to the last two. Following an abrupt change in the weather from warmer to colder we are always certain to find such cases.

In each of the three cases cited, the employee felt that he was hurt and was willing to hold the employer responsible. Indeed, there appears to be a growing tendency on the part of employees to hold the employer responsible for all manner of cases.

A review of Bulletin 272 of the U. S. Bureau of Labor Statistics (2), covering compensation cases in various states of the United States and in Canada, shows the greatest diversity of opinion in parallel cases as to what constitutes an accident, and how and when subsequent disease or death may be considered a result of accident. The tendency seems to be gradually to broaden the classification of conditions for which compensation may be paid. Out of the confusion which has arisen, as to what are really reportable injuries, we have adopted the following rule of action: As soon as possible after the injury, real or imaginary, we fill in a blank similar to the questionnaire shown in Figure 1. This will tell exactly what happened, and it will later be found of very great value to have recorded the exact statement of what actually happened as given by the employee at the very earliest moment following examination by the doctor. Lacking this clear, definite statement from the patient, the industrial physician will find himself at a very great disadvantage when presenting the case before the Industrial Commission. The borderline between accident and disease is so indefinitely drawn that, when a contest is arranged and the employee has been instructed by his attorney, he may

easily, intentionally or unintentionally, by inserting a few simple words such as "slipped" or "fell," change the entire complexion of the case.

It seems highly desirable that the employer, before assuming responsibility for the many questionable injuries, should request a hearing before the Industrial Commission in order to determine the responsibility in the particular case in question. This is a long, tedious and tiresome method, and one which we seldom employ because of the fact that it tends to destroy the confidence of the patient in the physician if there is any contest before treatment is undertaken.

The nature of the case often makes it difficult or impossible to request a hearing before the Industrial Commission, as in the instance of G. A. (*vide supra*). Because of the fact that the physician who has done much industrial work will not care to go frequently before the Commission to testify, it is not desirable to hold too many hearings, since they tend to break down the close co-operation which should exist between a physician and his patient. There is also a great deal of difficulty due to the fact that it may take weeks or months for the Commission to arrive at a decision after the case has been given a hearing. During this time the patient is without treatment unless the employer wishes to assume responsibility before the decision is made. If he adopts this method, it really offsets the purpose of having a hearing.

In answer to the question, "When are disabilities of the back arising out of patho-

Figure 1

QUESTIONNAIRE REGARDING INJURY

Name ...

Address ... Dept. ...

How long with company? When did accident occur? ...

What happened? ...

...

...

...

What were you actually doing when the accident occurred? ...

...

...

Is this your regular work? ...

Did you slip or fall, or were you struck? ...

If you lifted an object, what was the weight? ...

Did you have any assistance? ...

Witnesses to accident ...

...

Did anything unusual happen which you believe caused this injury? ...

...

...

Whom do you blame? ...

Have you ever had any injuries or accidents before? ...

Did you report accident to anyone? ...

*Date* ... M.D.

logical conditions called reportable accidents?" we are frank to admit that in many instances we are unable to decide. It is our belief, however, that many cases *now* reported as accidents need not be so carried. We feel that, by the application of the methods already outlined, we have been able to diminish the number of reportable cases. Inasmuch as in this state the power of determining what is an accident lies in the hands of the Industrial Commission, the logical thing to do seems to be to bring the case early to the attention of the Commission and ask for a decision. The physician who has at hand a careful detailed record of the events attending the so-called "accident," together with his physical findings, will always be in a better position to furnish satisfactory testimony before the Commission than the physicians who fail to have such a record. When an employee has gone on record as having stated that the disability developed in this or that way, he is not so apt to change his mind later, especially if he knows that his physician has a typewritten sheet at hand on which is contained the statement which he made at the time of injury. It is only reasonable to feel that such a statement must have some weight before the Commission, in view of the fact that it was taken at the time of the injury.

Before reporting any borderline cases, however, it is of greatest benefit to have a thorough physical examination and laboratory study of the case. As pointed out above, these studies will frequently reveal some chronic condition as the underlying cause of the disability. It is much more satisfactory and conclusive to have at hand the information which these studies bring to light, than to report a borderline case to the Commission as an accident and be compelled to furnish such information at a later date.

Under the existing compensation law in New York State, the employer will gradually be compelled to have a complete physical survey of all new employees. There would be many fewer deaths from syphilis aggravated by back injury if there were more routine Wassermann tests; X-ray studies of the chest would help to reveal pulmonary tuberculosis; and urine examinations would disclose diabetes and nephritis. These chronic diseases contribute to the greatest number of death claims in our experience. Each one, we believe, could have been avoided if our preliminary entrance examination had been sufficiently thorough, and often enough repeated.

If the employer will, by job analysis, inform the medical department what is expected from a new employee, and will supply the department with adequate personnel, laboratories and other facilities, he may hope to cut down the number of death claims and borderline back injuries. In this way only can he succeed in reducing these cases to a minimum. Laboratory examinations can necessarily be done more cheaply and more effectively in great numbers of cases than they can be done by a physician working on an individual case. It is in such work as this that the industrial physician can make his greatest contribution to the employer, the employee, and the community.

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# PICRIC ACID IN INDUSTRIAL SURGERY*

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PICRIC acid, $C_6H_2(NO_2)_3(OH)$, or trinitrophenol, is an odorless substitution product of phenol, and occurs in light yellow crystals or needles. Heretofore, it has had very limited use in the practice of medicine, being chiefly employed in a 1 per cent. aqueous solution as a dressing for superficial burns, for erysipelas, and as an anthelmintic. During the World War, however, the British Army Medical Corps (1) used a 5 per cent. solution of picric acid in 95 per cent. alcohol as an antiseptic in open wounds and for preparing the skin preceding minor and major operations, and had very gratifying results.

During the last two years I have treated approximately 4,000 cases of minor cuts, severe lacerations, punctured wounds, compound fractures (principally of the bones of the hands and feet) and other cases common in an industrial plant, and have used as the antiseptic, in all these cases, a 5 per cent. solution of picric acid in 95 per cent. alcohol. In fact, I have entirely discarded tincture of iodine. Practically all wounds that were sutured healed by primary intention and without infection, and better results were obtained with the use of picric acid in cuts and lacerations than were formerly obtained with the use of iodine. The wound, as a rule, remains clean and heals more quickly. From my experience, I think that I am justified in saying that picric acid (5 per cent.) can be applied to any part of the body, excepting the eye, without any untoward results. It can be used as an antiseptic for any condition for which iodine is used, and with better results. It is less irritating to the skin than iodine; it has mild anesthetic qualities; it is staple; it is less toxic; and last, but not of least importance, it is comparatively cheap.

It has been demonstrated that the penetrating power of picric acid on the skin is about the same as that of other germicides, *i. e.*, it penetrates only as far as the stratum corneum. The tanning qualities of picric acid are an important factor in the treatment of wounds. Pedicles of tanned skin form over areas which are painted with it, and in this tanned area are enmeshed the bacteria, which are prevented from entering the wound and spreading over the adjacent area of skin. This is theoretical, of course, but the principle is sound and plausible. The main fact is that in the cases mentioned above picric acid was an efficient antiseptic.

I have prepared the skin preceding minor operations with the alcoholic 5 per cent. picric acid, and have seen very few cases of infection. In at least one large New York hospital (2) picric acid is used exclusively in preparing the skin preceding major operations. Gauze saturated with a 5 per cent. aqueous solution of picric acid has the advantage over sterile gauze in that it is antiseptic and can be made absolutely sterile by live steam sterilization. If the gauze is then allowed to dry, an ideal surgical dressing results.

There is, however, one great objection to picric acid which should be mentioned here — namely, the tenacity with which the stain clings to the skin. I have as yet found no reagent that will entirely remove it from the skin, although it is easily removed from clothing and dressings by simply washing them in water. As picric acid in the crystal state is highly inflam-

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mable, care must be taken to keep it away from open flames.

In conclusion, I wish to give the following list of the advantages of picric acid over iodine and other similar antiseptics, as observed in my clinical experience and as substantiated by laboratory findings:

1. Its comparative cheapness
2. Its mild anesthetic qualities
3. Its stability
4. The fact that it does not irritate the parts to which it is applied
5. Its non-toxic qualities (even when used in large amounts over extensive areas)
6. Its power of hastening healing, the wound resulting in a smooth cicatrix
7. The fact that it can be applied to any part of the body, excepting the eye, with absolute safety.

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# SUGGESTIONS FOR CUSPIDORS IN INDUSTRIAL PLANTS*

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WHILE attending the recent annual meeting of the National Association of Industrial Physicians and Surgeons the author was asked by an industrial physician for a large rolling mill if he could give him any suggestion for solving the problem of cuspidor location in the mill. There seems to be no suitable place for the ordinary metal cuspidor; it is always getting in the men's way and becoming battered and banged beyond usefulness, or being upset and its contents spilled. If no cuspidors are provided, however, the workmen are constantly expectorating promiscuously on the rolling floor or in accumulations of dirt and dust, and the partially dried sputum, if it contains infectious micro-organisms, becomes a menace in the form of dust. As the suggestion given by the author seemed to the plant physician to be a practical solution of this problem, it is given here in the hope that it may be of service to others and adaptable in other industrial locations.

The suggestion made was to have the ordinary trumpet-mouthed metal cuspidor or a modified two-piece fiber cuspidor set in a concrete pit (Figures 1, 2 and 3) so that its top is level with the floor and consequently does not offer an obstruction to the worker nor get in the way of working materials or tools. A location can certainly be found for the placing of such pits not too far from the place of work and yet where the open mouth of the cuspidor will not offer an accident hazard to the worker's heel or toe. If this cannot be done, the top of the opening may be covered with a coarse grating which can be swabbed off periodically with a disinfectant.

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The opening for the cuspidor should be in the center of a 3-foot circular or square steel or concrete plate which should be kept free from dust or clutter and should be swabbed off daily when the cuspidors are removed for cleaning. Removal of the cuspidors for cleaning can be conveniently and

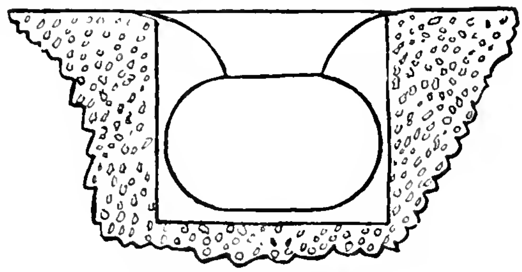

Fig. 1. — Cross section of metal cuspidor in concrete pit.

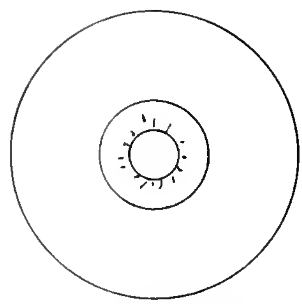

Fig. 2. — Top view of Figure 1.

safely accomplished, without touching any contaminated surface, with the use of expanding metal tongs. If a two-piece fiber cuspidor is used, the flare top must extend several inches beyond the sides of the bowl so as to give a surface to engage the edges of the pit.

For many other shop locations the same idea can be used of having a stationary, permanent location for a cuspidor so placed as to be free from any danger of upsetting or denting. Where feasible, the cuspidors can be sunk in a raised concrete block just a few

inches larger in diameter than the opening for the cuspidor, or possibly, better still, the cuspidor can rest in an iron ring attached to the side of a press, lathe, or other machine. (See Figure 4.)

Where many cuspidors are used in a large plant, the question of a safe and efficient means of cleaning them is not an unimportant one. Cuspidors should contain a small amount of liquid, preferably some cheap disinfectant as lysol, creolin, or other cresol preparation. They should be collected daily, if much used, and should be thoroughly cleaned before replacing. In a large plant, a hand truck can be provided to carry clean cuspidors and remove soiled ones for cleaning. This truck may also have a place for a jar of disinfectant with a swab for cleaning the surface surrounding the pits and the gratings, when these are necessary. Cuspidors can be easily and simply sterilized by inverting over a steam jet such as is used in many dairy farms for sterilizing large milk shipping cans. They may be placed over hoppers draining into the sewage system.

In some instances the removable cuspidor may be dispensed with entirely and replaced by metal or concrete funnels set in the floor and draining into the sewage sys-

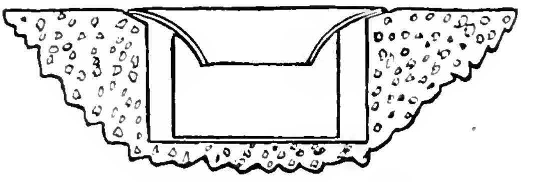

FIG. 3. — Two-piece fiber cuspidor in its pit.

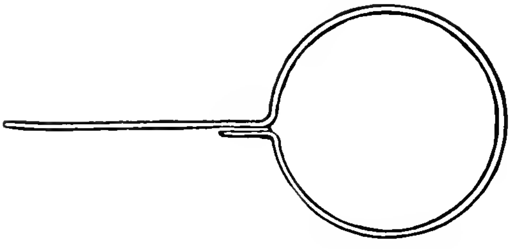

FIG. 4. — Strap iron ring to be bolted to machine as support for metal cuspidor.

tem or into sand pits. The funnel should be swabbed out regularly and thoroughly with disinfectant solution.

The accompanying drawings may, perhaps, give a clearer idea than the text of some of the suggestions made above.

# SPRAY INFECTION *

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IN the crowding together of human beings in factories, public conveyances, restaurants, cinemas, etc., one of the factors that tells against health is massive infection with organisms sprayed out from the mouth and nose by the carriers of pathogenic germs. In the open air such infection is negligible and good ventilation and proper spacing out can largely mitigate the massiveness of infection in places where people congregate indoors. The following research has been directed toward finding out how certain conditions affect the massiveness of spray infection.

## I. The Effect of Humidity of the Air

Trillat and Mallein (1) compared the influence of humidity and dryness of the air on the duration of the suspension of a spray of microbes by spraying into bell glasses 4 cg. of an emulsion of microbes, the emulsion being made by diluting 1 cg. of a solid culture with 50 c.c. of water. Petri dishes were exposed after three and ten, or fifteen and twenty minutes, and the number of colonies counted after incubation of the culture medium which coated the dishes. Their figures show a greater number of colonies in air with 60 per cent. humidity than in dry air, a much greater number in supersaturated air, and a still greater number in air sprayed with some food substance, such as bouillon. They suggest that the microbes grow and multiply in the droplets of bouillon when suspended in air. The method is obviously open to error, as there is no guarantee that the spray in each bell glass is of the same order and distribution. We have failed to confirm their results in the case of relatively humid and dry air.

The method which we employed in our experiments was as follows: Two bell glasses were selected of equal size and with a ground flat edge at the bottom, and a tubulure at the top. The edges were vaselined and brought into apposition, and the nozzle of a spray inserted through one of the tubulures (Fig. 1). The bell glasses were placed in a horizontal position. Three strokes of the spraying pump were then made and the tubulure closed. The two bell glasses, now held in apposition vertically, were inverted four times at intervals of thirty seconds, so as to mix the suspen-

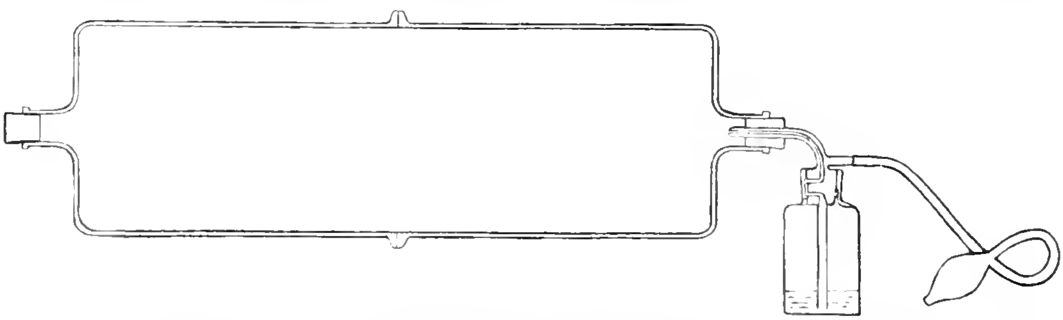

Fig. 1. — Diagram showing the two bell glasses held in apposition horizontally, and nozzle of spray inserted through one of the tubulures.

* Received for publication July 5, 1921.

sion equally. They were then gently separated and each one placed on a glass plate (Fig. 2) for transport, and then over the central orifice in the cover of one of the two chambers in which the Petri dishes were exposed (Fig. 3). These chambers were cylindrical and made of glazed earthenware. The Petri dishes were

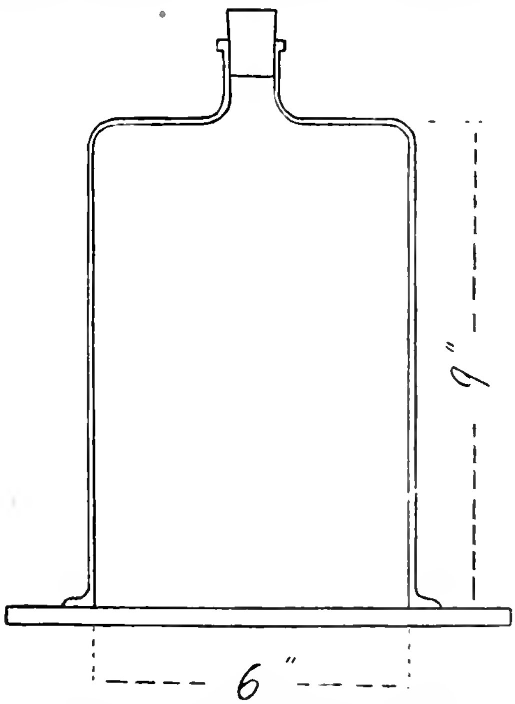


Fig. 2.—Bell glass on a plate ready for transport.

placed on a stand about 6 inches from the bottom of the chamber. The covers of the cylinders were glass and their apposition secured to the flat-topped edge by vaseline. A central circular orifice cut in the glass cover was closed by another glass plate curved on one side to fit the edge of the bell glass and so arranged that it could be pushed aside when the bell glass was sl'd into position. To the cover of each Petri dish was affixed a lump of hard wax to which a string was attached. The strings passed through pinholes in the glass cover closed by plasticine, so that by pulling on the strings the lids of the Petri dishes were raised and the culture medium exposed. One of the chambers was dried by a current of dry air, and basins of sulphuric acid and phosphorous pentoxide were placed on the floor in order to keep the air dry. In the other chamber which had been kept closed with a basin of water on the floor, the air was damp.

In the first experiment of this kind plates were exposed for two, five, and ten minutes after the bell glasses had been put in position. The result was that crowded colonies developed all over the plates in both the wet and the dry chambers In the next experiment we exposed the plates for two minutes at times shown in Table 1, with the result that the difference between the wet and dry chambers was found to be insignificant. The temperature of the chambers was 13°C. and the relative humidity of one 90 per cent., of the other 44 per cent., taken by wet and dry bulbs introduced at the end of the observation.

## II. The Effect of Cold

Trillat and Mallein found that mice were much more readily infected when placed in a cold chamber and exposed for from one to three minutes to a suspension of the infecting microbes, than was the case when the chamber was warm. Moreover, they carried out the following experiment:

A chamber *A* of 50 liters' capacity was connected to a chamber *B* of 20 liters' capacity by a tube 10 m. long and 2 cm. in diameter. Into *A* the spray of microbes was made; in *B* mice were placed. If *B* were cooled the mice became infected, but no infection occurred if *B* were kept at the same temperature or warmer than *A*. Obviously the infection was due to condensation by cold of the air in *B*, and consequent drawing of the infected air from *A* into *B*.

We spread a microbic spray uniformly through two bell glasses *A* and *B* as in our previous experiment, and, after separating them, placed them on glass plates so that

they could be carried about without disturbing the contained spray. Bell glass *A* was then placed over the perforated cover

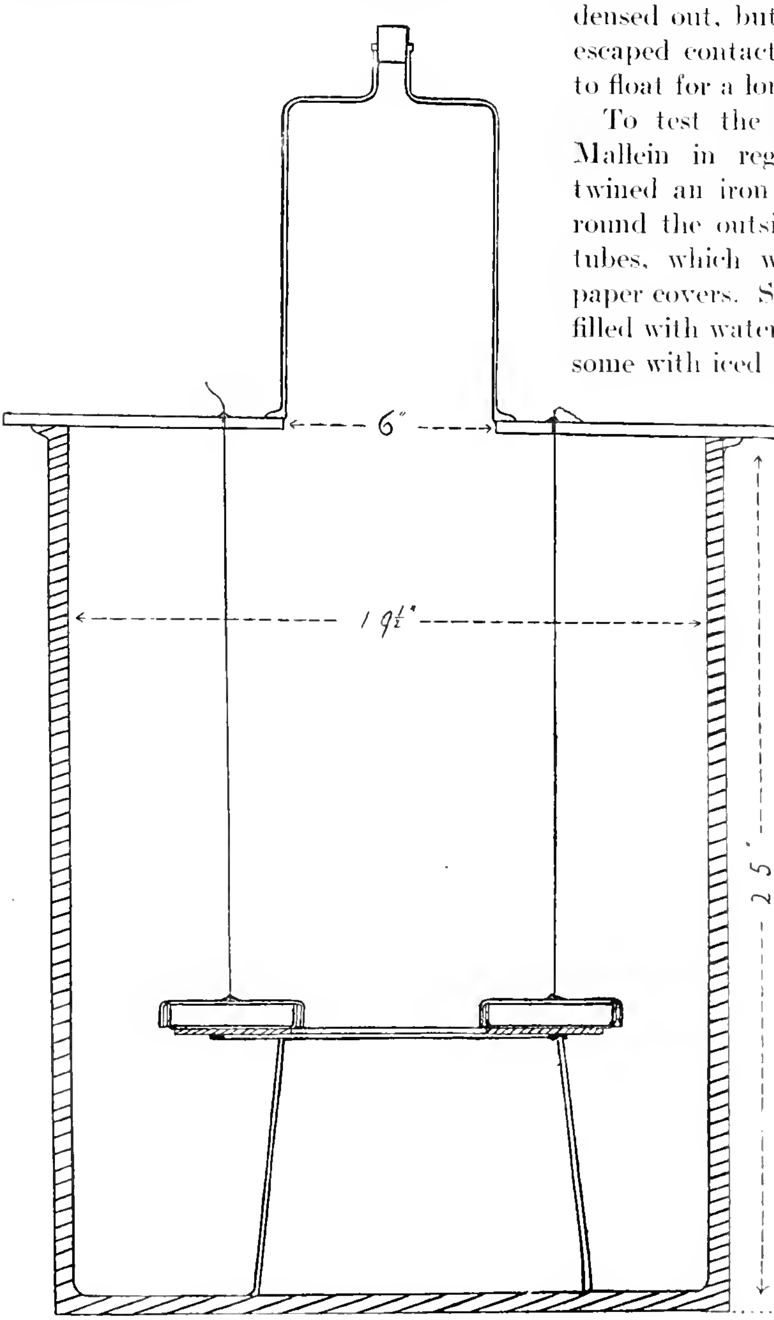


FIG. 3. — Diagram showing bell glass placed over the orifice in the cover of a chamber in which Petri dishes containing culture media are exposed.

of a chamber which had been placed in the hot room at 37.5°C. some hours previously, while *B* was placed over a chamber in the cold room at 3°C. Table 2 gives the results. We suggest that more microbes became at once affixed by the cold walls, together with the moisture which was condensed out, but the few organisms which escaped contact with the walls continued to float for a long time.

To test the suggestion of Trillat and Mallein in regard to condensation, we twined an iron wire in a series of bands round the outside of each of several test tubes, which were then sterilized inside paper covers. Some of the tubes were then filled with water at body temperature, and some with iced water, and after the paper covers had been removed were placed on a stand near the bottom of the chamber. A microbic spray was then made in a bell glass as before, and the spray allowed to settle from this into the chamber. After exposure for five minutes, a piece of wire was cut from each test tube and dropped into melted agar medium, and this, being shaken with the wire, was floated out into Petri dishes. Figures 4 and 5 show the difference in the results; many less colonies grew from the warm wires than from the cold wires.

In order to obtain a more exact idea of the difference in the number of organisms settling on the warm and cold wires, the following method was employed: After the tubes had been exposed, the wires were carefully removed with sterile forceps and dropped into a known volume (20 c.c.) of broth. The broth containing the wire was then thoroughly shaken so as to

loosen the organisms from the wire and distribute them in the broth. Measured quantities of the broth were then added to melted agar which, after thorough mixing, was poured into Petri dishes. These plates were incubated at 37°C. and the colonies were

TABLE 1. — RESULT OF EXPOSURE OF PLATES IN WET AND DRY CHAMBERS

| Dry Air | | Humid Air | |
|---|---|---|---|
| Exposure after | No. of Colonies | Exposure after | No. of Colonies |
| *hours* | | *hours* | |
| 1 | 17 | 1 | 33 |
| 2 | 8 | 2 | 11 |
| 3 | 5 | 3 | 5 |
| 4 | 0 | 4 | 1 |
| 5 | 0 | 5 | 0 |
| 6 | 2 | 6 | 1 |

counted after forty-eight hours. Taking the average of several experiments, the number of organisms (staphylococcus) found in a cubic centimeter of the broth, after it had been shaken with the wire, was 29 per c.c. in the case of the warm wire, and 120 per c.c. in the case of the chilled wire. It seems probable, then, that on coming

TABLE 2. — RESULT OF EXPOSURE OF PLATES IN WARM AND COLD AIR

| Warm Air | | Cold Air | |
|---|---|---|---|
| Exposure after | No. of Colonies | Exposure after | No. of Colonies |
| *hours* | | *hours* | |
| 1 | 400 | 1 | 26 |
| 2 | 20 | 2 | 6 |
| 3 | 0 | 3 | 2 |
| 4 | 0 | 4 | 3 |
| 5 | 1 | 5 | 3 |
| 6 | 0 | 6 | 0 |

into a crowded, warm room on a frosty day, hair, moustache, clothes, etc., will, owing to their lower temperature, affix microbes upon their surfaces in greater numbers than would be the case if the temperature were higher. Thus, too, Trillat's mice may have been more massively infected in the cold chamber.

The effect of a cold surface on suspended particles is shown in the following experiment: We took a glass tube 3 cm. in diameter and 1 m. long and inserted into either end of it a short U-tube through

FIG. 4. — Number of colonies growing from warm wires after five minutes' exposure to microbic spray.

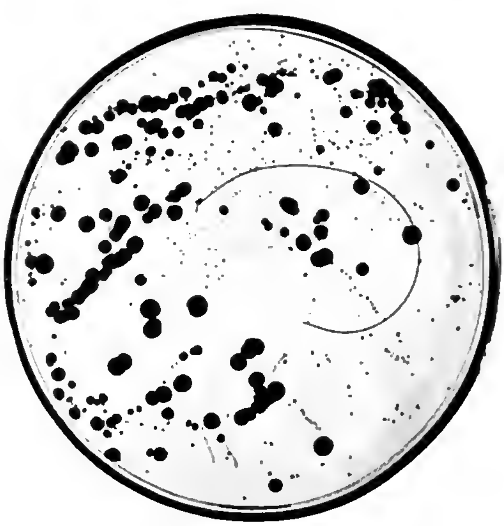

FIG. 5. — Colonies growing from cold wires after five minutes' exposure to microbic spray.

which circulated in one case iced water, and in the other case water at body temperature. We then drew tobacco smoke through the tube so as to fill it with a cloud of smoke from end to end. We found the smoke cleared round the end fitted with the cold U-tube and particularly round the

end of this tube, leaving a space as shown in Figure 6. Smoke eddies could also be seen at this place. At the end fitted with the test tube containing warm water no change appeared. The condensation of moisture of the air by the cold surface leads to many more particles, such as smoke and microbes, coming in contact

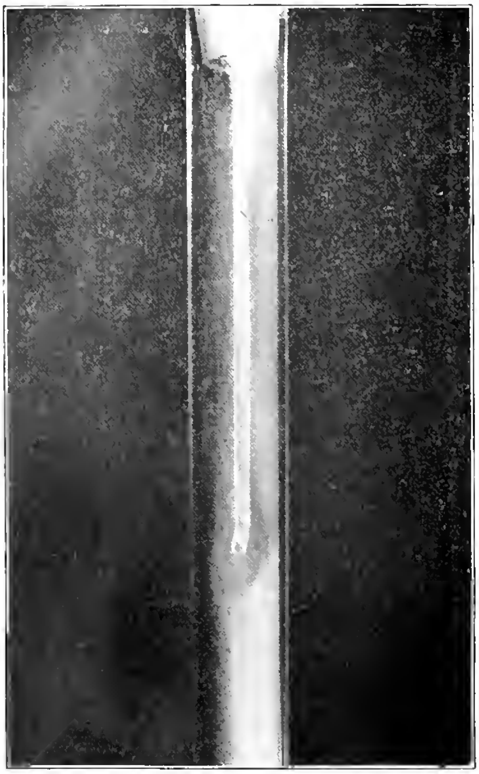

Fig. 6. — The smoke-free space at the end of the U-tube shows the effect of the cold surface of the U-tube on the suspended particles of smoke.

with the surface, and they become fixed thereon, whether because they are carrying an opposite electrical charge, or otherwise, we cannot say.

### III. The Effect of a Current of Saturated or Dusty Air on Transport of Microbes

Trillat and Mallein state that either water-saturated or dusty air carries away from the surface of a culture many more organisms than does dry air. This statement we have confirmed. Dry air from a compressed air cylinder was passed over a culture of staphylococcus, which grew along the floor of a tube *A* placed horizontally. In sequence to this tube was another tube *B* lined with sterilized agar culture medium. Air flowed through the two tubes for two and one-half minutes at the rate of 10 liters per minute. Only one or two colonies grew subsequently in *B*. The experiment was repeated, but this time with air first bubbled through warm water to saturate it. Some of the water condensed in *B*; this was grossly infected.

In a third experiment, the dry air passed through a bottle in which some dry sterile talc was shaken to make a dust. Many more colonies appeared in *B* under these conditions than when dry air alone was passed over the culture. In a fourth experiment, saturated and dusty air was passed over the culture and this caused gross infection in *B*. We conclude, therefore, that particles of water or dust in moving air on hitting infected surfaces carry away the microbes from these surfaces and in this manner help to spread infection.

### IV. Experiments Made to Investigate the Effects of Ventilation in Rooms Massively Infected with a Spray of Culture

We made a spray in an empty room (21 by 16½ by 13½ feet) heated by steam radiators, and exposing Petri dishes, usually five for each observation, compared the number of colonies formed, first, when the room was comfortably ventilated by open windows so that it felt fresh, and secondly, when the windows were all shut and the room felt close.

Seven and a half c.c. of a broth culture of a coliform bacillus (from a rabbit's intestine), diluted 1 in 5, were sprayed across the blast from a fan directed toward

TABLE 3. — AVERAGE NUMBER OF COLONIES RESULTING FROM EXPOSURE IN FRESH AND CLOSE ROOMS

| No. of Plate | Exposure for Two Minutes after | No. of Colonies | |
|---|---|---|---|
| | | Fresh Room | Close Room |
| | *minutes* | | |
| 1 | immediate | 1,593 | 1,468 |
| 2 | 5 | 446 | 634 |
| 3 | 10 | 54 | 272 |
| 4 | 15 | 38 | 118 |
| 5 | 20 | 1 | 76 |

the ceiling so that the organisms might be equally distributed throughout the air. The original culture contained about 300,000,000 living organisms per cubic centimeter, and it was found that by the above technic a

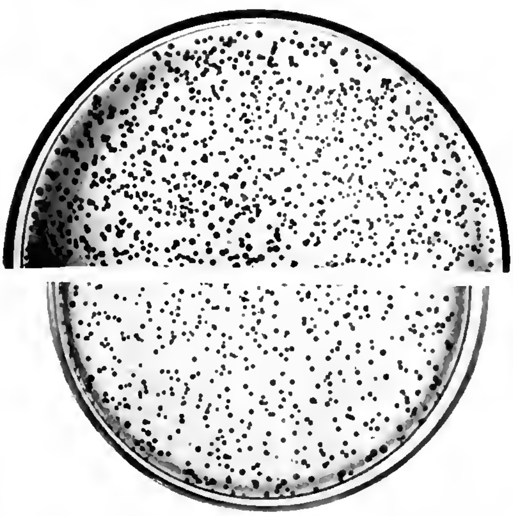

FIG. 7. — Photograph of plate 1 after exposure, immediately after spraying, in close room (upper half), and in ventilated room (lower half).

very even distribution of the organism was obtained. In the fresh room the dry bulb read 17.2°C., the wet bulb 12.8°C., and the dry kata-thermometer reading was 6°. In the close room, the dry bulb read 21.4°, the wet bulb 15.5°, and the dry kata-thermometer 4.2°. The Petri dishes were exposed for two minutes immediately, and at intervals of five, ten, fifteen and twenty minutes after making the spray. The number of colonies in the five plates after each exposure agreed very closely; the average number of colonies being shown in Table 3. The area of culture media exposed was very nearly equal. Figures 7, 8, and 9 are from photographs

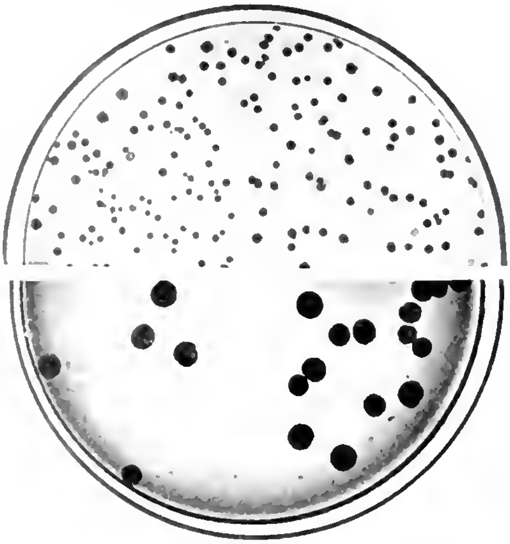

FIG. 8. — Photograph of plate 3 after exposure, ten minutes after spraying, in close room (upper half), and in ventilated room (lower half).

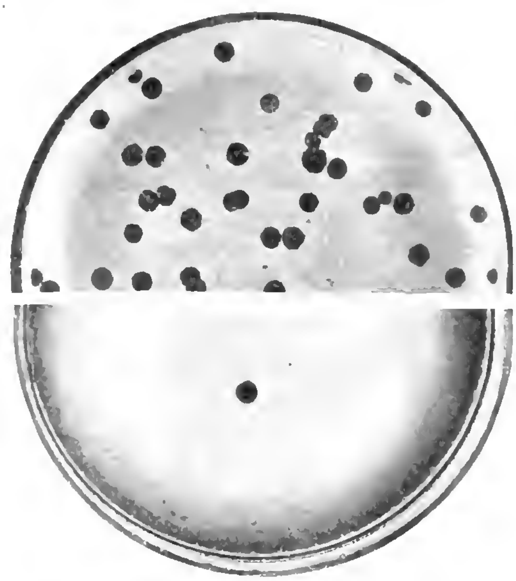

FIG. 9. — Photograph of plate 5 after exposure, twenty minutes after spraying, in close room (upper half), and in ventilated room (lower half).

of plates 1, 3, and 5; the close room plate being shown in the upper half in each case. It is clear, then, that opening the window enough to change close conditions into

those which feel fresh lessens massive spray infection greatly.

We next repeated the experiment in the close room, first, with the fan running so as to keep the air in constant movement, and, secondly, with the fan at rest. With the fan at rest the dry bulb read 22.5°, the wet bulb 14.5°, and the dry katathermometer 4.1°. With the fan running the readings were 22°, 14°, and 5.6°. Table 4 gives the average number of colonies formed. This experiment shows that the movement of the air, caused by the fan, takes away more than double the number of microbes, probably by bringing them in contact with walls and other surfaces and by driving them out of the room through crannies.

TABLE 4.—AVERAGE NUMBER OF COLONIES RESULTING FROM EXPOSURE IN CLOSE ROOM WITH FAN RUNNING AND WITH FAN AT REST

| No. of Plate | Exposure for Two Minutes after | No. of Colonies | |
|---|---|---|---|
| | | Fan Off | Fan On |
| | *minutes* | | |
| 1 | immediate | 1,750 | 1,700 |
| 2 | 5 | 680 | 510 |
| 3 | 10 | 425 | 230 |
| 4 | 15 | 200 | 84 |
| 5 | 20 | 97 | 40 |

Lastly, we tried the experiment in the relatively dry close room, and in the same room made moist by a number of baths of water kept boiling by Bunsen burners, and by water scattered over the floor and walls. In the dry close room the dry bulb read 21.2°, the wet bulb 12°, and the dry kata-thermometer 4.3°; in the moist close room the readings were 23.5°, 20.5°, and 4.0°, respectively. The number of colonies is recorded in Table 5. In the moist room the number of microbes was notably more reduced, partly, we suggest, owing to their condensation together with water vapor on the walls and other surfaces, partly owing to stronger outward currents being set up through crannies because of the greater lightness of the moist air, and partly owing to the fact that a large number of organisms must have been destroyed by the twelve or more Bunsen burners which were employed in heating the water used to saturate the air.

TABLE 5.—AVERAGE NUMBER OF COLONIES RESULTING FROM EXPOSURE IN DRY AND MOIST CLOSE ROOM

| No. of Plate | Exposure for Two Minutes after | Dry Close Room | Moist Close Room |
|---|---|---|---|
| | *minutes* | | |
| 1 | immediate | 1,540 | 2,610 |
| 2 | 5 | 690 | 1,025 |
| 3 | 10 | 540 | 452 |
| 4 | 15 | 215 | 157 |
| 5 | 20 | 121 | 68 |

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# CARBON MONOXIDE, ILLUMINATING GAS, AND BENZOL: THEIR EFFECT ON BLOOD COAGULATION TIME *

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In carbon monoxide poisoning, pathologists describe hemorrhages in the brain, muscles, lungs, and other organs (1). Some authors state that the blood postmortem remains fluid in the vessels much longer than usual and does not readily clot when withdrawn (2). Others say that carbon monoxide favors coagulation (3). On account of these diverse findings and because of differences of opinion regarding the mode of action of the gas, it seemed worth while to determine carefully the coagulation time of the blood of animals gassed with carbon monoxide and to note any evidence of blood destruction (*e. g.*, hemolysis).

Convincing proof has been brought forward by the physiologists that this gas has no direct harmful action upon nerve cells or other tissues, but injures solely by robbing these tissues of oxygen through the formation of a compound with hemoglobin which is not stable but which can be replaced by oxygen under suitable tension (4) (5). Many of the cases described in the literature as carbon monoxide poisoning are in reality, however, due to illuminating gas. The pathological pictures in poisonings by these two gases may well differ. Illuminating gas is complex and has been shown to be more toxic than is pure carbon monoxide, the chief additional poison being benzol (6) (7). The other toxic constituents — xylene, ethylene, etc. — appear to be much less important so far as is known at present. It has been shown by Hurwitz and Drinker (8) that repeated subcutaneous injections of benzol can cause delayed coagulation, but this does not happen immediately. According to their figures, the change is slight after four days from the first injection, and is not marked till the tenth day; therefore, a change is hardly to be expected, even from intensive gassing, within the time limits of the present experiments. We have tried to find out in these experiments whether or not, under controlled conditions, pure carbon monoxide, illuminating gas, and pure benzol have any measurable effect on coagulation time.

## Method

Cats anesthetized with urethane or ether supplied control samples of blood. With urethane the dosage was 10 c.c. of a 25 per cent. solution per kilo weight of cat given by stomach tube. One carotid was exposed and 2 c.c. samples * were drawn directly into a cannula-tipped pipette. This was previously coated with a saturated ether solution of vaseline, the ether being afterwards carefully expelled. From the pipette 1 c.c. of blood was delivered into the bottom of each of two test tubes, which were thoroughly clean and dry, and of uniform diameter. These tubes were kept in a water-bath at 31° to 32° C. After standing ten minutes, they were tilted slightly once every five minutes. The end point was the firm holding of the clot so that the blood did not run down the side when the test tube was inverted. Time was taken from the moment the blood entered the pipette. A few determinations were made on blood oxalated and recalcified after the method of Howell (9).

* The authors wish to express their thanks to Dr. Cecil K. Drinker and Dr. Katherine R. Drinker for valuable suggestions and help. Received for publication Sept. 12, 1921.

* Occasionally 3 c.c. samples were taken and put into three test tubes.

After control samples had been taken from the urethanized animal, the gas was given from a Douglas bag by a tracheal cannula, fitted with inspiratory and expiratory valves. In the different experiments the duration of gassing varied from thirty minutes to seven and one-half hours. For the longer periods, instead of being permitted to inhale the gas by tracheal tube, the animal was placed in a box of 760 liters' capacity, to which a measured amount of gas was added. An electric fan kept the air in motion, and the excess of carbon dioxide and moisture was absorbed by soda lime.

The carbon monoxide, which we used, was made from formic acid and sulphuric acid heated to 70° to 80°C., and the gas passed through strong sodium hydrate solution and collected in a bottle by displacement of water. The illuminating gas was taken from the laboratory gas jet. It was supplied by the Boston Consolidated Gas Company, and the figures giving the average monthly percentage of carbon monoxide were obtained through the courtesy of the chief chemist of the company. The benzol used was "Benzene (Benzol) Merck." The percentage of vapor inhaled by the animals was not determined but was of sufficient concentration to keep them unconscious.

## Experimental Data

Eleven experiments have been chosen from the total number performed. A number were discarded because of lack of uniformity among the controls before a constant temperature bath was used. In the prothrombin tests, uniformity was obtained without the use of a water-bath, and it was, therefore, omitted.

The accompanying protocols show the extent of the individual variations in coagulation time.

Protocol 1. — Cat 1. Weight 3.1 kg. Urethane 31 c.c. 25 % solution given 2 hours and 22 minutes before gas started. Gassed 82 minutes with 0.5 % CO.

*Normal Blood*

| Sample | Coagulation Time Tube 1 *min.* | Tube 2 *min.* | Tube 3 *min.* |
|---|---|---|---|
| A | 25 | 25 | 25 |
| B | 20 | 20 | 26 |

*CO Blood*

| Sample | Tube 1 | Tube 2 | Tube 3 |
|---|---|---|---|
| A taken 21 minutes after starting gas | 20 | 20 | 25 |
| B " 38 " " " " | 20 | 20 | .. |
| C " 55 " " " " | 20 | 20 | .. |
| D " 72 " " " " | 20 | 20 | .. |
| E " 82* " " " " | 20 | 20 | .. |

* Heart had stopped when sample was taken.

Protocol 2. — Cat 2. Weight 2.9 kg. Urethane 29 c.c. 25 % solution given $1\frac{3}{4}$ hours before gas started. Gassed 61 minutes with 0.5 % CO.

*Normal Blood*

| Sample | Coagulation Time Tube 1 *min.* | Tube 2 *min.* |
|---|---|---|
| A | 35 | 35 |
| B | 30 | 26 |

*CO Blood*

| Sample | Tube 1 | Tube 2 |
|---|---|---|
| A taken 10 minutes after starting gas | 30 | 30 |
| B " 24 " " " " | 35 | 31 |
| C " 40 " " " " | 30 | 26 |
| D " 48 " " " " | 25 | 20 |
| E " 56 " " " " | 35 | 35 |
| F " 61* " " " " | 20 | 30 |

* Heart stopped 2 minutes before sample was taken.

Protocol 3. — Cat 3. Weight 3 kg. Urethane 30 c.c. 25 % solution given $1\frac{1}{2}$ hours before gas started. Gassed 47 minutes with 0.6 % CO.

*Prothrombin Test*

| Oxalated Blood *drops* | 1 % $CaCl_2$ *drops* | Coagulation Time Control *min.* | CO Sample *min.* |
|---|---|---|---|
| 5 | 1 | 9 | 8 |
| 5 | 2 | 9 | 10 |
| 5 | 3 | 11 | 11 |
| 5 | 4 | 12 | 11 |
| **Oxalated Plasma** *drops* | **1 % $CaCl_2$** *drops* | **Control** *min.* | **CO Sample** *min.* |
| 5 | 1 | 20 | 22 |
| 5 | 2 | 21 | 20 |
| 5 | 3 | 20 | 20 |
| 5 | 4 | 20 | 20 |

PROTOCOL 4. — Cat 4. Weight 2.2 kg. Urethane 18 c.c. 25% solution given $2\frac{3}{4}$ hours before gas started. Gassed 39 minutes with 0.7% CO (in two periods with two 69-minute intervals).

*Prothrombin Test*

| Oxalated Blood drops | 1% $CaCl_2$ drops | Coagulation Time Control min. | Coagulation Time CO Sample min. |
|---|---|---|---|
| 5 | 1 | 4 | 3 |
| 5 | 2 | 5 | 3 |
| 5 | 3 | 5 | 4 |
| 5 | 4 | 7 | 4 |

PROTOCOL 5. — Cat 5. Weight 2 kg. Urethane 20 c.c. 25% solution given $2\frac{3}{4}$ hours before gas started. Gassed 30 minutes with 0.6% CO.

*Prothrombin Test*

| Oxalated Blood drops | 1% $CaCl_2$ drops | Coagulation Time Control min. | Coagulation Time CO Sample min. |
|---|---|---|---|
| 5 | 1 | 6 | 5 |
| 5 | 2 | 6 | 4 |
| 5 | 3 | 7 | 5 |
| 5 | 4 | 9 | 6 |

PROTOCOL 6. — Cat 6. Weight 2.5 kg. Urethane 30 c.c. 25% solution given 1 hour before gas started. Gassed 34 minutes with 2% illuminating gas (containing approximately 0.5% CO).

*Normal Blood*

| Sample | Coagulation Time Tube 1 min. | Coagulation Time Tube 2 min. |
|---|---|---|
| A | 30 | 30 |
| B | 25 | 30 |

*Illuminating Gas Blood*

| | | |
|---|---|---|
| A taken 8 minutes after starting gas | 21 | 25 |
| B " 15 " " " " | 20 | 25 |
| C " 23 " " " " | 25 | 25 |
| D " 28 " " " " | 25 | 30 |
| E " 34 " " " " | 30 | 30 |

PROTOCOL 7. — Cat 7. Etherized 40 minutes till gas started. Gassed 5 hours in box with 0.5% illuminating gas (containing approximately 0.12% CO).

*Normal Blood*

| Sample | Coagulation Time Tube 1 min. | Coagulation Time Tube 2 min. |
|---|---|---|
| A | 15 | 10 |
| B | 20 | 10 |
| C | 15 | 15 |

*Illuminating Gas Blood*

| | | |
|---|---|---|
| A taken $4\frac{1}{2}$ hours after starting gas | 15 | 10 |
| B " $4\frac{1}{2}$ " " " " | 20 | 10 |
| C " $4\frac{1}{2}$ " " " " | 25 | 10 |
| D " 5 " " " " | 20 | 20 |
| E " 5 " " " " | 20 | 10 |

PROTOCOL 8. — Cat 8. Etherized 35 minutes before taking control samples. Exposed to benzol vapor in box for 3 hours. Unconscious.

*Normal Blood*

| Sample | Coagulation Time Tube 1 min. | Coagulation Time Tube 2 min. | Coagulation Time Tube 3 min. |
|---|---|---|---|
| A | 25 | 20 | .. |
| B | 25 | 20 | 20 |

*Benzol Blood*

| | | | |
|---|---|---|---|
| A taken 3 hours after starting gas | 30 | 20 | . |
| B " 3 hrs. and 5 m. after starting gas | 30 | 30 | .. |
| C* " 3 " " 10 " " " " | 40 | 40 | 50 |

* Taken $1\frac{1}{2}$ minutes after heart stopped.

*Autopsy.* Blood as dark in arteries as in veins. Right lung congested, hemorrhagic, edematous; intestinal vessels appear contracted and pale, showing marked contrast to those of CO animals, which are always greatly dilated.

PROTOCOL 9. — Cat 9. Etherized before taking control samples. Exposed to benzol vapor in box for 3 hours. Unconscious.

*Normal Blood*

| Sample | Coagulation Time Tube 1 min. | Coagulation Time Tube 2 min. |
|---|---|---|
| A | 20 | 25 |

*Benzol Blood*

| | | |
|---|---|---|
| A taken 3 hours after starting gas | 15 | 15 |
| B " 3 " " " " | 15 | 15 |

*Prothrombin Test*

| Oxalated Blood drops | 1% $CaCl_2$ drops | Coagulation Time Control min. | Coagulation Time Benzol Sample min. |
|---|---|---|---|
| 5 | 1 | 3 | 3 |
| 5 | 2 | 3 | 3 |
| 5 | 3 | 4 | 3 |
| 5 | 4 | 4 | 4 |

PROTOCOL 10. — Cat 10. Etherized before taking control samples. Chilled by wetting and exposure to fan for 53 minutes. Rectal temperature reduced to 29.5°C. Exposed to benzol vapor in box for $3\frac{1}{2}$ hours after being warmed. Rectal temperature 33.5°C.

*Normal Blood*

| Sample | Coagulation Time Tube 1 min. | Coagulation Time Tube 2 min. |
|---|---|---|
| A | 25 | 25 |
| B after exposure to cold | 20 | 20 |

*Benzol Blood*

| | | |
|---|---|---|
| A taken after 1 hour of gas | 20 | 30 |
| B " " 1 " " " | 20 | 15 |
| C " " $3\frac{1}{2}$ " " " | 17 | 17 |
| D " " $3\frac{1}{2}$ " " " | 20 | 20 |

Protocol 11. — Cat 11. Gassed preceding day for $7\frac{3}{4}$ hours with benzol vapor. Unconscious most of that time. Appears normal on day of experiment; no sign of paralysis. No ether or urethane given. No control samples taken. Exposed in box to benzol vapor for $7\frac{1}{2}$ hours. Red blood count 8,000,000; white blood count 13,000; blood smear shows polynuclears and platelets increased.

| *Benzol Blood* Sample | Coagulation Time Tube 1 *min.* | Tube 2 *min.* |
|---|---|---|
| A taken after 6 hours and 24 minutes of gas | 25 | 25 |
| B " " 6 " " 45 " " " | 20 | 15 |
| C " " 6 " " 54 " " " | 25 | 25 |
| D* " " 7 " " 30 " " " | 20 | 20 |

* Taken from abdominal aorta 2 minutes after heart stopped.

## Discussion

The experiments which we have reported show no constant change of coagulation time in the blood of cats gassed with any one of the three gases tested, and the prothrombin content was apparently unaltered. Evidence of hemolysis was lacking. Clear serum was always obtained unless mechanical injury to the red cells had occurred. The urine was never dark or smoky. Since no hemorrhages were found postmortem, it is apparent that the exact conditions of human poisoning were not reproduced, even by five hours of deep coma in the gas. The one possible exception is seen in Protocol 8 where the lungs showed some extravasation of blood. This animal's blood showed a lengthening of coagulation time in the last sample, though it is doubtful if this is significant, for the sample taken only five minutes before showed a normal time. Protocol 9, on the other hand, with the same duration of exposure to benzol showed a slight shortening of coagulation time, but this again can be disregarded because the prothrombin test taken at the same time was normal.

In fatal human cases of illuminating gas poisoning the patient often lingers in coma for one or two days before death. This condition we were unable to duplicate in animals. They either died in the gas or recovered entirely. The most probable explanation of this failure to reproduce hemorrhages or prolonged coma after removal from the gas is either that it affects animals differently from human beings or, more probably, that the period of gassing is shorter in these experiments than in the human cases.

## Conclusions

Under the conditions of these experiments no measurable effect upon the coagulation time of the blood was found in cats gassed with carbon monoxide, illuminating gas, or benzol.

No evidence of hemolysis or of blood destruction was observed.

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# BOOK REVIEWS

**The Assessment of Physical Fitness by Correlation of Vital Capacity and Certain Measurements of the Body.** By Georges Dreyer, C.B.E., M.A., M.D., Fellow of Lincoln College, Professor of Pathology in the University of Oxford, Corresponding Member of the Royal Danish Academy of Letters and Sciences, and George Fulford Hanson, Late Lieutenant U.S.A. Medical Corps, Air Service. With a foreword by Charles H. Mayo, M.D., Rochester, Minn. Cloth. Pp. 127 with illustrations and index. New York: Paul B. Hoeber, 1921.

This book is a collection of tables through the use of which it is held possible to arrange individuals in the order of their physical fitness. The author has established certain relations between weight, sitting height, chest circumference, and vital capacity, which are indicative of good health. He does not include any of his data upon the validity of these relations but includes references to previous papers in which he has discussed the development of his conceptions.

The reader is given a series of tables with thorough directions as to their use for the following purposes:

"1. The determination of what are the normal proportions between the weight, the trunk-length, and the circumference of the chest.

"2. To gain evidence as to underfeeding or malnutrition during different stages of adolescent or adult life, as well as in various classes and occupations of the population.

"3. For the study of the different aspects of physical fitness as measured by vital capacity in its relation to weight, trunk-length, and chest-circumference; for the comparison of adolescents with adults, and of the male sex with the female; for the comparison of different trades, occupations, and classes one with another, referring all to a definite common standard.

"4. The application of these various measurements to patients with organic disease—*e.g.*, pulmonary tuberculosis—as well as to persons with functional disorders—*e.g.*, industrial fatigue, the fatigue of aviators, and so on."

Since the usefulness of Dreyer's tables can only be established through experience with them, no opinion can be expressed as to the soundness of these contentions. The whole subject is of such vital interest to industrial physicians that it is hoped they will at once begin to utilize and criticize the methods and standards which the author has furnished.—*C. K. Drinker.*

**Occupational Affections of the Skin.** Their Prevention and Treatment, with an Account of the Trade Processes and Agents Which Give Rise to Them. By R. Prosser White, M.D. Ed., M.R.C.S. Lond., Life Vice-President, Dermatologist, Senior Physician and Euthetic Officer, Royal Albert Edward Infirmary, Wigan; Vice-President Association Factory Surgeons; Life Fellow London Dermatologists' Society; Member Manchester Medical and Dermatologists' Societies; Hon. Life Member St. John Ambulance Association; Associate Editor, Journal of Industrial Hygiene. Cloth. Second Edition. Pp. 360 with illustrations and index. New York: Paul B. Hoeber, 1920.

The first edition of this book, published in 1915, proved itself of great worth in a comparatively neglected and difficult field. In this, the second edition, which is greatly amplified, useful material has been added to almost every chapter. Deserving of especial mention are the chapters on dermatitis venenata and the dermatoconioses. The added illustrations are excellent and the numerous references, which have been carefully and painstakingly compiled, will prove a great help to investigators in this line of work.

It is a book which fills a long felt want and deserves a prominent place in the library of every worker in industrial hygiene, while the dermatologist who reads it will soon discover that to him it is not a luxury but a necessity. It is to be hoped that in the future there will follow other editions to add to the literature in this complex and ever-widening field.—*E. Laurence Oliver.*

## HEALTH INSTITUTE OF THE AMERICAN PUBLIC HEALTH ASSOCIATION

One of the features of the Fiftieth Annual Meeting of the American Public Health Association is to be a Health Institute which will be held in New York City from November 8 to 11, the convention itself taking place the following week, November 14 to 18. The Institute is open to non-members of the American Public Health Association.

Among the demonstrations tentatively included in the program for the Industrial Hygiene Section of the Institute are:

Industrial Hygiene and Welfare Work of the New York Telephone and Telegraph Company.

Industrial Hygiene Work of the New York City Health Department.

Industrial Hygiene Work of the American Telephone and Telegraph Company.

National Industrial Conference Board Exhibit of Charts and Discussion of Cost of Industrial Welfare.

Industrial Welfare Work of the Metropolitan Life Insurance Company.

Industrial Hygiene Work of the New York City Health Department.

# THE JOURNAL OF INDUSTRIAL HYGIENE

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## THE PROBLEM OF HEART DISEASE IN THE INDUSTRIAL WORKER *

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HEART disease and industry are not incompatible. An individual may be productive even while bedridden with heart trouble a large part of the time. The active trained mind of a cardiac cripple may be more valuable in industrial progress than a body in perfect health controlled by a dull intellect. In general, we have been inclined to shelter too much our young patients with heart disease. They can usually do more than we have permitted. An example of the interest expressed in their own future as a group is a letter which I received recently from a young man 20 years of age who has been crippled since childhood by rheumatic heart disease, and for that reason unable to obtain all the education which he desired, and who is now facing the need of supporting himself without the best training for a clerical job. He is unable to do hard physical work and cannot obtain even light work because of the stigma of his heart disease. His plea for the future of the whole group of young people with heart disease overshadows all the rest of his letter. He is a champion of their cause.

There are two problems of heart disease in industry: first, that of the individual worker; and second, that of the attitude of industry in general. My subject is concerned particularly with the problem of the individual, but in closing I shall discuss briefly the general relation of industry to heart disease.

### The Individual Worker

Every industrial worker with heart disease is a problem in himself. The solution of each problem depends on the answers to two short questions: How much work can the individual do? What is his future? If we can puzzle out the answers to these questions, we can solve the problem of heart disease in the individual industrial worker. The first question is a relatively easy one — to be ascertained at once by questioning the subject, by suitable tests, or by observing the subject while at work. The question would be better put as follows: How much work can the individual do without discomfort? — for sometimes a

* Read before the Health Service Section at the Tenth Annual Meeting of the National Safety Council, Boston, Mass., Sept. 29, 1921. Received for publication Oct. 17, 1921.

person will force himself to do work often very distressing and even injurious to himself.

The other question at times is a very difficult one to answer for the future of the individual depends on a number of factors. In the first place, a correct diagnosis is of prime importance, and yet is very often neglected. Symptoms of heart disturbance, such as palpitation (that is, the disagreeable sensation of the heart beat), pain in the region of the heart, and shortness of breath, do not by any means always signify heart disease. Nor do fainting attacks or weakness indicate heart disease. Nor do murmurs or rapid heart action mean a diseased heart. And yet I have often seen patients diagnosed by themselves, by their relatives or friends, or, not infrequently, even by their physicians as having heart disease, when to all methods of examination their hearts appear normal. This has been true in 60 out of 250 cases which I have seen in consultation (24 per cent.) in the last two years. To be sure, some of these people are incapacitated by their symptoms even though their hearts are normal; the nervous system or thyroid gland may be at fault. Though it may be impossible for such individuals to carry on ordinary work, the heart should not be blamed and treated, and cardiac statistics padded by these thousands of cases. The very first step in our problem, therefore, is to make a proper diagnosis. This having been made in its entirety, the rest, even the forecast of the future, is not difficult. The other important point in answering the question as to the future of a given case is the study of the individual's reaction to medical treatment or to a definite test of work over a given interval of time. An hour, a day, or a week may suffice to answer this.

*Diagnosis.* — Let me now take up these two steps — diagnosis and reaction to work — in more detail, since they are so vital in judging a case. Recently, diagnosis in heart disease has been put upon a sound basis, and I shall discuss briefly the system as it is now in use in the Heart Clinic at the Massachusetts General Hospital and, in somewhat similar form, in some other hospitals and cities. Because it is not widely used and because it has proved so useful, I wish to emphasize it in its value in the industrial health problem.

In former times, and not so far back either, as any one who received his medical diploma ten years or more ago will testify, heart disease consisted of mitral regurgitation and other such valve damage. A little was said about enlargement, myocarditis, and pericarditis. Disturbances of rhythm were beginning to be recognized in a hazy way, very shortly to flash up and take the lead for a while, with such diagnoses as heart block and auricular fibrillation (absolute arrhythmia) sufficing as diagnoses of heart trouble. At this same time Mackenzie's teaching of myocardial capacity was filtering in here and there, taught in a very disjointed way, unconnected with structural or etiological condition. Now, more than ever before, we see the tremendous importance of the cause of heart disease as a vital part of our estimate of the heart's condition and particularly of its future. Finally, at the present moment the best diagnosis we can make comprises all three factors — the cause of the trouble (or etiology), the degree of anatomical damage, and the extent of functional impairment. Unless all these three points are studied and stated, I consider the diagnosis of a case of heart disease inadequate. By using this method not only do we have a clear picture of the individual at the present time but also a very solid foundation for a prophecy as to his future.

Each diagnosis should include, then, all available information as to etiology, structure and function. If the cause of the heart disease is unknown, it should be so

stated. Such a declaration of our ignorance will stimulate us to study the individual further and to search more deeply into the causes of heart diseases in general.

The most common causes of heart disease are arteriosclerosis and rheumatic fever with its allied infections, such as chorea and tonsillitis. Syphilis and thyroid disease are other important causes. It is of much value in estimating the future of a person with heart disease to know what caused the disease. For example, given three hearts with organic defects of equal degree, the future is as a rule much brighter if the cause is rheumatic fever than if it is arteriosclerosis or syphilis. Until recently syphilitic heart disease carried with it an especially bad outlook — indeed, it was often only a question of a few more months of life. Now, under better treatment, the future is not quite so dark.

The next step in diagnosis is the determination of the actual degree of anatomical change so far as possible — the size of the heart, the valve changes, the involvement of the pericardium and the presence of disease in the aorta. Careful physical examination, supplemented if necessary by X-ray and electrocardiographic studies, will give a fairly good answer to this part of the problem.

And then finally we come to a very vital part of the diagnosis — the functional condition of the heart. Are there actual signs of heart failure, such as swelling of the feet, or is there severe heart pain or shortness of breath in the presence of a damaged heart? If so, there is heart failure — that is, decrease in cardiac capacity far below what it should be. We speak of the type of failure with the shortness of breath and edema as the *congestive*, and the type of failure with heart pain as the *anginal*. Both are significant of serious heart damage and weakness. Of course, there may be much heart disease without failure, but sooner or later in such hearts failure is apt to appear. All gradations of functional limitation of the heart's capacity exist, and following more or less one of the classifications of the New York Association of Cardiac Clinics we may speak of five groups of individuals with heart disease as follows:

1. Those able to carry on their habitual activities (without symptoms of distress);
2. Those able to carry on slightly curtailed activities;
3. Those able to carry on moderately decreased activities;
4. Those able to carry on only greatly diminished activity;
5. Those unable to carry on any of their habitual activities.

Finally, under the heading of functional diagnosis are to be included the disturbances of rhythm, rate and pressure, such as heart block, auricular fibrillation, hypertension and pulsus alternans.

A few examples will suffice to show the usefulness of this scheme of diagnoses. Take first a man 35 years of age who has a crippled heart following tonsillitis and rheumatic fever twelve years before. His heart condition has been diagnosed as a leaky valve. After he has been carefully examined the following diagnosis is made: "Rheumatic heart disease with aortic regurgitation and slight mitral involvement, cardiac enlargement, with normal rhythm and able to carry on habitual activities without symptoms." Now such a young man, although he has a loud murmur, may be able to live an active, useful life of many years; only late in life may symptoms of heart failure appear. The fact that rheumatic fever was the cause of his disease, the fact that his aortic valve is involved with little damage to his mitral valve (mitral stenosis would be more serious), the fact that he has a regular pulse, and, finally, the fact that he has no symptoms of heart failure make such a young man a good risk for the future. The only things which we must do with regard

to him are to be sure that his tonsils are removed if they are in the least diseased or if there is the slightest doubt as to their condition, and to avoid so far as possible further rheumatic infections (as a matter of fact best done by the tonsillectomy itself). There are many young people with heart trouble who are now being condemned as invalids and useless because they happen to have loud murmurs, about whom one may be as optimistic as I have indicated above.

Take another man, 42 years of age, who is beginning to have heart pain on exertion. He boasts, perhaps, that he never was sick in his life, but on careful questioning he admits that he had a venereal sore fifteen years before. On examination one finds his heart enlarged, with a slight but definite degree of aortic regurgitation, and a positive Wassermann reaction. His case is diagnosed as, "Syphilitic heart disease with aortitis, aortic regurgitation, cardiac enlargement and normal rhythm, able to carry on slightly limited activity." In spite of the fact that he may appear to be a robust man and may have only a slight aortic murmur, his future is very serious at the present stage of our medical knowledge. This is all due to the fact that syphilis is the cause in this instance, and not rheumatism. Once upon a time both of these men, the one of 35 and the one of 42, would have been classed simply as cardiacs with aortic regurgitation, the younger man with more marked valve damage than the older.

Finally, let us suppose another man, one 27 years of age, with shortness of breath and palpitation on moderate exertion and occasionally when excited. His symptoms are worse than those present in either of the two cases already cited. He gives a past history of the usual children's diseases without rheumatic fever or chorea. He has always been high-strung as his father was before him. His father is alive and well at the age of 64 years. The patient broke down at the front during the war after a long bombardment of his trench by the enemy. He was said at the time to have "disordered action of the heart," and has been more or less incapacitated since. People are afraid to give him work because of his symptoms and history; yet he is well educated and bright. His diagnosis is, "Nervous heart with no evidence of heart disease." He has a rapid heart beat at times of examination, and under strain is unable to carry on his ordinary activities as well as normally. Now such a man may be very valuable in industry. He is apt to be very quick to learn some delicate or intricate work and may accomplish much more in the end than his husky, stolid comrade who can do a hard day's work with the pick and shovel but who rarely has an idea pass through his brain. Let us remember this large group of keen, nervous individuals who cannot stand a hard strain but who are able none the less to accomplish a great deal. Such young men and women, in spite of their symptoms, will undoubtedly outlive the men with syphilitic and rheumatic heart disease. Our chief concern in such cases is to protect the sensitive nervous system. The heart is sound enough.

These three examples are, I believe, enough to show the great importance of establishing a correct and complete diagnosis in each employee with heart disease. Sometimes a case is baffling, but if so, let us confess it and closely follow the individual until we can arrive at the correct conclusion, if it be possible.

*Functional Tests.*— After the diagnosis has been determined, the other essential point in the proper estimation of a person's capacity and future is the actual test. Many articles have been written about testing the heart's function and some facts of value can be extracted from them. We must realize, however, that in a given case it is not the cardiac function that we meas-

ure with all our tests but the physical fitness of the individual as a whole. His nervous system plays a part in his response to the tests as well as his heart and other muscles. The reaction of the pulse rate, blood pressure, respiratory rate and general condition to measured exercise, such as stair climbing, hopping on one foot, running a given distance and swinging dumb-bells, has been studied and all these exercises have their advocates. Dr. May Wilson (1) of New York has been attempting to find the "equivalent of ordinary exertion" by standard tests particularly dumb-bell swinging. Two iron dumb-bells swung from the floor to full stretch of arms overhead and back again between the legs at a constant rate of two seconds for each swing were used in testing children from 6 to 15 years of age. The weight of the dumb-bells varied from 3 to 20 pounds, and the number of swings from ten to thirty. Thus, in her classification, mild exercise for the children of from 6 to 8 years consisted in swinging two 1½-pound dumb-bells ten times, while strenuous exercise for children of from 12 to 15 years consisted in swinging two 10-pound dumb-bells thirty times. Now by carrying this or some similar test a step further we may roughly correlate it to industry. If the measurement of physical action in a certain occupation can be figured in foot-pounds or kilogram-meters per unit of time, we may be able to arrive at some sort of estimate of the cardiac ability, *always included in the general fitness of the individual*, by the test of a like amount of work in a unit of time in dumb-bell lifting.

Papers by Barringer (2) (3), Rapport (4), and Mann (5) have in the last few years taken up the question of the significance of blood pressure and pulse rate changes in man after exercise tests, particularly the dumb-bell test.* Conclusions to be drawn from their work are that the pulse rate changes following exercise are unreliable as evidence of circulatory condition, but that the systolic blood pressure curve is of some value in judging limitations of physical capacity, not of cardiac capacity. Rapport, in working with Lewis, showed that "as an immediate sequence of accomplished exercise, whether that exercise is moderate in degree, or whether it calls forth a full effort on the part of the person who performs it, there is a rise of systolic blood pressure." In criticizing Barringer's reliance on a delayed rise as indication of limitation of cardiac capacity, Rapport quite rightly says:

> To speak of the rise ("delayed rise") itself as an index of a change in the circulatory reaction is, in the light of our experiences, unsound; to speak of a delay in the full development of the rise ["delayed summit"], with severe effort, is usually to speak correctly. . . . The work done by the heart in the intact and sentient animal at rest has never been accurately computed; still less has the *capacity* of the heart for work in circumstance of overload. It has become fashionable, nevertheless, to express the capacity of the heart for work in terms of measure, terms which do not measure that capacity, but something which is quite different. . . . A curve of systolic blood pressure during or following exercise may be an exact expression of real events; but these events are blood pressure events and the measure is of blood pressure and not of cardiac work [or cardiac capacity].

Nevertheless, it is true that as the degree of exercise done approaches the limit of an individual's physical capacity, *whether he be normal or affected with heart disease*, the rise in blood pressure following the test shows a more and more delayed summit. With the extreme in delayed summit in a given person go symptoms of distress — dyspnea and exhaustion. Right here it should be said that a healthy person untrained may show this sign and these symptoms with considerably less exercise than a person with heart disease who shows

* Lifting a 25-pound bar over the head is a useful variation of the dumb-bell test.

no failure and who has excellent reserve power.

Two examples of the systolic blood pressure exercise test will make clear some of the points just mentioned. The man 35 years of age (and 150 pounds in weight) with rheumatic heart disease and aortic regurgitation, whom we have already cited, is examined at rest for fifteen minutes before the exercise. His blood pressure, at first 130 mm. Hg. systolic, becomes on the second measurement 120 mm., and is thereafter fixed at 120 mm. His pulse rate before the exercise is steady at 76. He is then put through the test consisting of swinging two 10-pound dumb-bells thirty times from the floor above the head at the rate of one swing every two seconds. He shows slight breathlessness and weariness at the end of the exercise; his pulse rate is 108 and his systolic blood pressure 140 mm. Hg. thirty seconds after the exercise is stopped. (Ten seconds after the exercise the systolic pressure is 130 mm.) One minute after the exercise the blood pressure becomes 135 mm., and the pulse rate 90; and at the end of two minutes the pressure is 125 mm. and the pulse rate 70. This is quite a normal reaction.

For the second case let us take the man 42 years of age with the syphilitic heart disease and aortic regurgitation, whom we have also cited. He is put through exactly the same exercise as the previous man but complains of considerable precordial pain and is very breathless at the end of the exercise. His systolic pressure has gone up from his normal pressure of 130 mm. to 145 mm. at the end of one-half minute, to 160 mm. at the end of one minute, and stays at that point after one and one-half minutes. At two minutes the pressure is 150 mm., and at three minutes 140 mm. His pulse rate, at first 80, becomes immediately after the exercise 160, at the end of one minute 140, and at the end of two minutes 100. It is obvious that the test more than taxed the strength of this man. The delayed summit of the systolic blood pressure is here well marked.

Certain factors enter into such exercise tests, however, that render them imperfect. In the first place, muscles may be in use quite different from those exercised in the particular occupation; secondly, there is an added strain due to nervous excitement at the time of the test; and, thirdly, the test lasts but a few minutes at the most, while the job in question lasts several hours every day. Thus, only a very rough estimate of individual physical and cardiac ability can be made from such tests. Stair-climbing, running and hopping are all open to the same objections.

There are no short cuts to determining the heart's power that I know of which are of universal value. Respiratory tests have been suggested, such as the length of time the breath can be held, the height to which a mercury column can be blown, the length of time the mercury column can be maintained at a certain height, and the vital capacity. As in the case of the exercise tests, if these are normal the individual's heart cannot be in a very bad condition. The vital capacity test, which is the measurement of the amount of air that can be expired after a full inspiration, and the test of holding the breath are useful measures of the degree of heart failure present. Vital capacity and the power of holding the breath are also reduced in marked psychoneurosis (6). Similarly in these conditions the carbon dioxide rebreathing test shows a capacity below normal. But the only sure way to determine whether a man with heart disease can stand a certain job is actually to try him out at it. No two jobs are exactly alike and no two individuals have exactly the same kind or degree of heart disease. A few minutes, a few hours, or a few days at the most will answer our question. Having by observation, examination and some simple test roughly deter-

mined the fitness of the individual, the exact measurement of his strength, cardiac and general, in relation to a certain job must come from the job itself. We must remember, moreover, that it is possible to train a man for a job physically as well as mentally though he appear incapable at the first trial. There are occupations for all kinds of cardiac cripples. A man unable to climb a flight of stairs without shortness of breath is obviously unfit to work as a freight handler, but he may prove very useful in keeping the office files. A concise folder has been published recently by the Association for the Prevention and Relief of Heart Disease (7) giving lists of occupations — both skilled and unskilled — generally suitable for people with heart disease. This folder can, I believe, be obtained on request from the office of the Association at 325 East 57th Street, New York City.

### General Relation of Heart Disease to Industry

Having finished this brief discussion of the problem of heart disease in the individual worker, I should like to conclude with a few remarks on the problem of the relation of heart disease to industry in general. In the first place there is not, so far as I know, any industrial heart disease. There is, of course, effort syndrome, but for that industry is not to blame. The relation of industry to the production of arteriosclerosis is still a question to be solved. Arteriosclerosis is a very important cause of heart disease as I have said, and if years of hard work produce arteriosclerosis, then industry may be accused of causing heart disease. The factors of the individual's susceptibility to arteriosclerosis, of the exciting effect of hard physical or mental work, and of the time element of hours of work per day or week must eventually be studied and weighed before we can point out how industry may be relieved of the possible blame of inducing arteriosclerosis.

In helping to eradicate heart disease, industry should insist on the proper physical examination of the worker. If the tonsils are diseased, their early removal may prevent rheumatic heart disease or prevent the increase of such disease if already present. It is very worth while to try to eradicate rheumatic fever for it is one of the serious scourges of the youth of the land. If there is a history of syphilis, or if the Wassermann reaction is positive, proper intensive treatment may prevent syphilitic heart disease. Proper education and campaigning against venereal disease (including the adoption of prophylaxis if necessary) will also help, for syphilitic heart disease, as I have already said, is a very serious matter. Early recognition and treatment of thyroid disease may avert thyroid heart complications. Avoidance of long-sustained excessive physical or mental effort, and the insistence on regular periods of relaxation should reduce the degree of presenile arteriosclerosis.

People should, on the average, live far longer than they do, though the 300 years of age advocated by the Barnabas Brothers in Shaw's *Back to Methuselah* is a bit too great a jump from our modest three score and ten to accomplish at the moment. To increase the average life, infectious disease must be eradicated, cancer overcome, and accidents and the strain of work reduced. There is, in general, too high a tension in American life, both in work and in play. We do not sit long enough at the breakfast table or over the teacups — we might do well here to take a leaf from the leisurely ways of the European. An engine run at high speed all the time wears out too quickly. The human machine, too, is liable to break down eventually with accident to the heart or brain.

Not only may industry do its share in the prevention of heart disease but it may also do its part in the prevention of heart failure in the individual worker who has heart dis-

ease. The tremendous improvement in the care of the health of workers carried out by industrial concerns all over the country makes it possible to check up frequently the physical condition of the worker with heart disease. By examinations given weekly or monthly or at intervals as circumstances demand, the earliest symptoms or signs of failure may be detected and proper recommendations as to treatment given. Rest in bed for a day or two at such a time may save the individual weeks of illness and loss of income later. It may prove to be very valuable insurance. Some of the cardiac clinics in New York meet on Friday evenings so that their patients may be advised to stay in bed for the week-end if necessary, with little or no loss of time from their work.

A word should be added concerning the need of special vocational training of young people with heart disease so that they may be able to support themselves comfortably later in life in occupations which will not involve physical or mental strain. Special classes have already been instituted in connection with the public school system of New York City with this aim in view.

Finally, let me repeat that heart disease and valuable productive ability may coexist in the same individual. We must know the kind and degree of the heart damage. Knowing this, we should be able properly to place the worker by using our common sense, by tests for a rough estimate of the physical capacity of the individual, and, finally, by the actual test of the work itself.

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# CARDIAC DISEASE AND ITS RELATION TO INDUSTRIAL EFFICIENCY *

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At a time when we are taking stock of our resources and looking for means of increasing the national output by reducing our losses from disease, it behooves us to study not only the mortality records but also such figures as are available to tell us what diseases cripple men and women and lower their standard of efficiency. The best figures to which we can turn for such information are those supplied by the Ministry of National Service and drawn from their recruiting experiences. From the tables which they have published, it appears that about 10 per cent. of the men rejected as unfit for military service were rejected on account of valvular disease of the heart. In some districts, indeed, this kind of disability was responsible for more rejections than any other. This figure is to some extent discounted by the fact that cardiac murmurs were too readily received as evidence of valvular disease by recruiting authorities, the result being that many men who might have made efficient soldiers were rejected on inadequate grounds. On the other hand, we have to recollect that of the four great causes of organic heart diseases — to wit, rheumatic infection, syphilis, high arterial tension, and "senile" arteriosclerosis — the first alone finds a large proportion of its victims among persons of military age. The others fall with heavier incidence on men past the age of 40. Moreover, it must be remembered that rheumatic heart disease attacks women rather oftener than men. It is therefore clear that cardiac disease is responsible for a very great wastage of the nation's strength.

It is scarcely necessary to impress upon the medical profession the need for a more concerted plan of attack upon these diseases. Already, in America at all events, there are signs of such a movement. Nor should we expect or wish the profession to regard this attack on disease primarily from the commercial standpoint. Our chief motive for such an attack is, and always ought to be, the prevention and relief of suffering. But it is nevertheless needful to impress upon those who must find the money essential to such a campaign, that the study of disease and its causes will pay its own way, not at once, of course, but as the years and decades go by, with unfailing certainty.

What, then, is to be our plan of campaign? Let us first review the objectives, and then pass to a brief consideration of strategy. In any attack upon disease the first objective must always be out-and-out prevention. Where prevention is not possible, we must fall back upon plans for the arrest of disease. Finally, in cases of severe and established disease, we must have plans for treatment, and these must include economic treatment.

First, how is cardiac disease to be prevented? There is no disease that needs more time and energy devoted to the study of its causes than does cardiac disease. Even if the belief, which I share, in the streptococcal origin of rheumatic heart dis-

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ease be accepted, we are still far from knowing much about the influence of such matters as climate, soil, density of population, and so forth, on its initiation. Thanks to a grant from the University of Bristol Colston Research Society, and to the help of Dr. D. S. Davies and his clerk, Mr. W. N. Brown, I have been able to make an investigation into the incidence of rheumatic heart disease, based on the mortality records of Bristol. The results of this research have already been published,* and I am looking forward to an extended inquiry into the same matter on a basis of data more reliable than those furnished by death certificates. Even in cardiac syphilis, where so much is known as to the exciting cause, how little is known as to those factors which predispose to the incidence of the infection on the heart rather than on some other organ! And when we turn to those forms of cardiac disease which are related to high arterial tension or arterial degeneration, or both, it must be confessed that our study of their causation is little better than a mass of conjectures.

I do not believe that we can get far in these researches into the factors predisposing to disease without enlisting the help of every medical practitioner. Before this can be done, however, medical men must be trained to think etiologically in the matter of heart disease. If we consult any of our textbooks of medicine, we find that the pages devoted to cardiac disease are divided into paragraphs on "mitral regurgitation," "heart block," and so forth — titles which describe symptoms, not diseases. Not until they are replaced by such headings as "cardiac rheumatism," "cardiac syphilis," and so forth, shall we get students and practitioners to think of cardiac disease as something with a tangible beginning, a plant which ought not merely to be nipped in the bud, but actually to be prevented from getting any place whatever in the ground.

This kind of description of cardiac disease can only be built up on a systematic study of the whole subject. What is wanted is exhaustive examination of a large number of cases of cardiac disease, with careful records of the features of each, and classification into such etiological groups as I have already indicated. For example, we ought not to be content with recording such cases of cardiac syphilis as manifest evidences of heart block; every case of the disease ought to be studied with the electrocardiograph, and the presence or absence of block in its various grades noted. When all such information has been duly collected, it will be possible to write a connected account of each of the forms of cardiac disease, classified under headings which bear reference to causation. Then the medical profession will be armed with the information essential to a study of factors predisposing to cardiac disease, and we shall be able to get on with our task of finding out what those causes are. As I have already said, this can only be carried out by the general co-operation of the whole profession, and some better plan must be devised than the present one, by which family doctor, laboratory worker, and medical officer of health work separately from each other.

As to the second line of objective — arrest of disease in an early stage — there is little enough to be said, with one exception, and that relates to rheumatic heart disease in its childhood stage. The course of this disease is one of progress, not sustained or interrupted, but marked by a series of active phases, each lasting a few days or several weeks. In a certain percentage of cases the child is killed by the first of these phases. In a very few there is but one such phase, from which the child recovers, without further recurrence. In most cases the active phase of the disease

* Coombs, C. F.: The Incidence of Fatal Rheumatic Heart Disease in Bristol, 1876-1913. Lancet, 1920, **2**, 226.

recurs from time to time, each attack leaving the heart more damaged than before, so that the patient, if fortunate enough to survive into adolescence or adult life, finds himself handicapped at the outset of his wage-earning career by a crippled heart. Only too often his education has been so interrupted by the active phases, which keep him away from school, that he is fit for nothing but general labor. Ill equipped in mind, and dangerously crippled in body, he has little chance of doing any useful work. It would be well worth while to make some provision for his education to be carried on quietly during his periods of illness or, at all events, of convalescence — such provision as is being furnished in the analogous case of the tuberculous cripple. There is no reason why the same building that houses the latter, providing both treatment and education, should not be used for the rheumatic child also. Indeed, I believe that this is actually done at the Liverpool Country Hospital for children. The number of beds needed in each large city would not be great; one might begin with a dozen in Bristol, for example.

Arrest of other forms of cardiac disease in an early stage does not at present seem practicable, though it is possible that closer study of cardiac syphilis might discover evidences earlier than those at present known to us. Unfortunately, this and the arterial types of cardiac disease attack the patient when he has already reached or passed the watershed of life, so that his chance of effecting successful repair is small.

The third line of objective — better treatment of established disease — comes within the scope of this article only in its relation to the patient's capacity for work. One of the lessons of the war has been that many people with severe cardiac lesions can nevertheless do a surprising amount of work with impunity. Unfortunately, however, it is difficult for such people to compete in the open labor market with those whose hearts are sound. Employers are surprisingly considerate in such cases, but it is impossible, under the industrial conditions of the moment, to arrange for the interrupted work of these cripples in workshops and factories that are geared to run continuously at a high rate of efficiency. On the other hand, during the periods which many of them spend in the hospital, under observation, they have nothing to do, and this does no good to their morale. They would be better in every way if they had some kind of occupation. Workshops, similar to those provided for crippled ex-service men, ought to be attached to the hospitals so that these patients might be given an opportunity of combining productive work with institutional treatment.

In order to bring into being these proposals, little or no expenditure on building would be needful. All that is required in each large city, in each university city at all events, is that there should be such a rearrangement of the existing resources as to provide the team of practitioners specially interested in cardiac disease with a consultative out-patient department, hospital beds for the treatment of severe cases, and premises for the housing and treatment over long periods of such cases as I have alluded to in the two preceding paragraphs. The team must also have at its disposal such electrocardiographic and other apparatus as is needful for the careful and systematic study of cardiac disease. By this means knowledge will be gained which will be imparted to the students — the practitioners of the immediate future. Last but not least, this central organization must be in touch with the practitioners of the area. This will confer benefit in both directions — on the cardiac specialists, who would gain the breadth of view and sense of proportion that close attention to one branch of medicine is apt to impair; and on the general practitioners, who

would assimilate and apply each new discovery as it was made.

As an outcome of such co-operation it should be possible not only to diminish appreciably the sum total of human suffering, but also to effect such an economy of man-power as amply to repay the moderate outlay necessary for the initiation and maintenance of the organizations proposed in this article.

# CHRONIC MANGANESE POISONING: TWO CASES*

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IT is the purpose of this paper to call attention to two cases of manganese poisoning occurring in steel workers who were engaged in handling manganese in the Bessemer process of making steel.

Manganese poisoning, though a comparatively rare finding, presents a symptom complex, definite and constant enough to be readily diagnosed, and should be suspected in workers handling manganese. This metal is used in the chlorine industry and to aid in liberating chlorine gas, in the liberation of oxygen, in dyeing, coloring glass, charging galvanic cells, in making lacquer, varnish and oil paints, enamel and linoleum, and in marbling soap. Manganese poisoning is also noted in workers in industries dealing with other metals or their ores, in which manganese exists as an impurity, and it was under such conditions that Casamajor (1) met his cases. Manganese is used extensively as an alloy with nickel and steel.

The number of cases of manganese poisoning is not large nor is there an extensive literature on the subject. Couper (2), in 1837, described characteristic symptoms in workmen in a chemical factory where manganese dioxide was ground in the manufacture of chlorine for bleaching powder. In 1901 (October 7), R. von Jaksch (3) described similar symptoms in three workmen employed as grinders of manganese dioxide, but diagnosed the findings as atypical cases of multiple sclerosis. H. Embden (4), in an article also published in 1901 (October 15), described characteristic symptoms in men employed in grinding manganese dioxide, and correctly diagnosed chronic manganese poisoning. In 1903 and 1904, respectively, Friedel (5) and Seiffer (6) reported cases which presented characteristic symptoms. Several years later von Jaksch (7) (8) and Seelert (9) summed up the fifteen cases of manganese poisoning in Europe described in the above-mentioned articles, and in 1913, Casamajor reported nine cases occurring in this country. In 1919, Edsall, Wilbur and Drinker (10) summarized the literature to date and reported the details upon three of the thirty cases which they examined.

## Etiology

The chief etiological factor by means of which manganese enters the system is undoubtedly coarse dust, though in the writers' cases fumes must have played a rôle. It has been pointed out by Oliver and others that most of our industrial poisonings are taken in the form of dust, and not so much the dust which is inhaled as that which is swallowed in the saliva. In his reports, von Jaksch stated that no new cases developed when the dust was abolished. Embden likewise ascribed his cases to manganese dioxide dust, as did also Casamajor and Edsall, Wilbur, and Drinker.

In order to supplement these clinical findings by analytical data, Reiman and Minot (11) made a study of the absorption and elimination of manganese ingested as oxides and silicates, in which they came to the following conclusions:

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Ores containing manganese as oxides and silicates are soluble in gastric juice. Manganese is absorbed in the blood stream causing in most cases a slight temporary rise in manganese concentration followed by a quick return to normal. In none of the cases studied was the manganese content of the blood increased by the ingestion of manganese ores to a value more than double the normal level, and in some of the subjects no increase was noted. We suggest that individuals of the first group would probably be more susceptible to manganese poisoning than those of the latter.

Even prolonged feeding of large amounts of manganese ore to dogs failed to produce significant changes in manganese content of blood and tissues or to cause any pathological symptoms. Manganese ores are thus very non-toxic and in order to produce symptoms of poisoning must be ingested by individuals who are peculiarly susceptible. Clinical experience [10] has demonstrated that such persons are extremely rare.

## Symptoms

Edsall, Wilbur and Drinker (10), who have made a careful review of the subject of manganese poisoning and have reported cases of their own, summarize the symptomatology thus:

As we have seen chronic manganese poisoning the following findings make the syndrome. We have numbered them in the most common order of appearance. It is difficult to emphasize in any written description the clearness with which the symptoms come out and the ease with which the diagnosis can be made.

1. A history of work in manganese dust for at least three months.

2. Languor and sleepiness.

3. Stolid, mask-like facies.

4. Low monotonous voice. Economical speech.

5. Muscular twitching, varying in degree from a fine tremor of the hands to gross rhythmical movements of the arms, legs, trunk and head.

6. Cramps in the calves and a complaint of stiffness in the muscles of the legs, the cramps usually coming on at night and becoming worse after a day of exertion.

7. Slight increase in tendon reflexes.

8. Ankle and patellar clonus. Frequently by stretching any of the muscles of the body it is possible to elicit rhythmical contractions. Romberg sign is inconstant; there is no incoordination.

9. Retropulsion and propulsion.

10. A peculiar slapping gait. The patient keeps as broad a base as possible, endeavoring involuntarily to avoid propulsion. The shoes are worn evenly and we have not been able to convince ourselves of the pronounced tendency to walk on the region of the metatarso-phalangeal joints, a feature strongly emphasized by von Jaksch [7].

11. Occasionally, uncontrollable laughter; less frequently, crying.

12. Uniformly absent are any disturbances of deep or superficial sensation, eye changes, rectal, genito-urinary or gastro-intestinal disturbances, reactions of degeneration, blood, urine, and spinal fluid alterations. It is significant that, unlike lead, manganese produces no life-shortening degenerations. Seriously poisoned men are long-lived cripples. The metal apparently makes a very definite attack upon some non-vital portion of the neuromuscular system, destroys it thoroughly, if time for action is permitted, and leaves the victim quite well in every other respect.

We have never seen either the salivation or edema described in foreign cases.

## Pathology

The pathology of this condition is not clear. Von Jaksch reported that he never found any pathological lesions postmortem, but he does not state the details of his investigation. Casamajor had an autopsy in but one of his cases. He reported the appearance of degeneration in the longitudinal fibres of the pons in isolated bundles lying mostly close to the raphé. This degeneration was seen only in the pons. He was unable to reproduce it in rabbits or dogs.

Further autopsy studies of these cases would be desirable, but as the patients do not die of manganese poisoning *per se*, and as cases of the poisoning are comparatively rare, little is known of the pathology.

## Treatment

Prophylaxis is the only hope in the treatment of chronic manganese poisoning. Inasmuch as dust was the means by which

poisoning occurred in the writers' cases, it is clear that, in order to remove all possibility of poisoning, dust must be eliminated from processes in which workers handle manganese. If this cannot be accomplished, the process should be rearranged or discontinued, as it was in the plant in question.

General eliminative measures by means of the kidneys, skin and intestines, etc., are indicated, but little is to be looked for in the way of improvement under such treatment.

### Prognosis

In patients manifesting minor symptoms, recovery may take place. If, however, the patient has progressed to more advanced stages, the disease may be arrested, but a cure will not be forthcoming. The disease is not fatal, and the condition of the patient continues for months or years without change.

### Report of Cases

The writers' two cases occurred in workmen who were occupied in the process of making manganese steel. A few words concerning the process may elucidate the environment in which they worked.

In the Bessemer process for making steel, molten iron from the blast furnaces is carried in large ladles to the converters, which are retorts shaped like an egg with a portion of the small end cut off. These converters are pivoted near the center and are so made that there are openings in the lower end from which heated gases may be blown through the molten iron, for the purpose of oxidizing a part of the carbon which is in solution in the molten iron. When this carbon is oxidized to a certain point, the resulting mixture is known as steel.

The molten iron from the blast furnace is poured directly into the opening in the top of the converter, after which the blast is turned on and the gases are forced through the molten iron. When the oxidation has progressed sufficiently, the blast is shut off and the converter is tilted so that the molten steel, which remains, runs from the opening in the top into a large ladle which is suitably placed to receive the steel as it pours from the converter. From this ladle the steel is withdrawn into moulds, and, after cooling, forms what is known as an ingot. The ingot is then made into the various shapes desired.

In the process of making manganese steel, manganese is added to the steel in a definite proportion and it immediately diffuses through the mass of steel. When the manganese is fused in the electric furnace, a definite amount of molten manganese is added to the steel and there results a product, the composition of which is uniform. Previous to the use of the electric furnace the solid manganese was added to the molten iron as it came from the blast furnace, and in the oxidation process a portion of the manganese was also oxidized, so that the resulting composition of the steel was not so definite nor so uniform.

In the operation of the electric furnace there are three large carbon electrodes, and the electric arc between these electrodes generates the heat which causes the fusion of the manganese. The electric furnace in use at the plant in question, when the two cases of manganese poisoning occurred, was a large steel chamber lined with firebrick and provided with two openings—one a sliding door (Figure 1*a*) through which the solid chunks of manganese were shoveled into the interior, the other a small opening connected with a spout (Figure 1*b*) from which the molten manganese was poured into a small ladle. The molten manganese in this small ladle was poured into the molten steel which had just been poured from the converter into the large ladle. When the sliding door was open for recharging the furnace, the heat within the furnace was

so intense that a considerable quantity of brown manganese fumes from the furnace escaped from the door into the surrounding atmosphere and entered the mouth, throat, and lungs of any person who was in the vicinity. Mr. S., superintendent of the

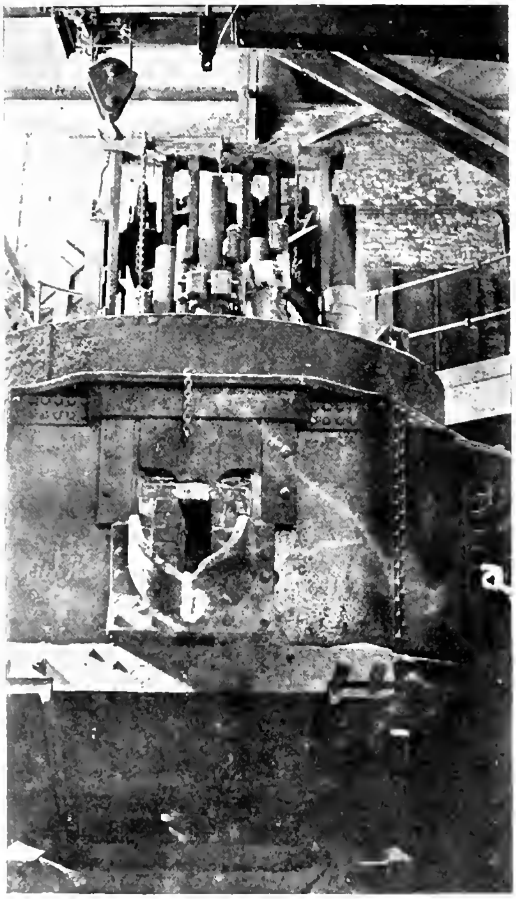

FIG. 1. — Electric furnace which was located in a room about 25 feet square.

(a) Charging door, into which the manganese was shoveled. At each charge the door was open long enough to allow 150 pounds to be shoveled in — about fifteen seconds — and during this time the fumes escaped freely.

(b) Spout from which liquid manganese was poured and from which fumes escaped in large quantities.

Bessemer department, stated that there was the same taste to the smoke that he had experienced when manganese had previously been ground and the dust had entered his mouth, and he believed that there was a considerable amount of manganese in the smoke which escaped. At his suggestion, therefore, the fumes from the electric furnace were analyzed, and were found to contain a high percentage of manganese, as did also the dust on the ledges in the same room. (See Table 1.)

TABLE 1. — ANALYSIS OF COARSE DUST AND FUMES FROM ELECTRIC FURNACE

| Substance | Analysis of Coarse Dust from Electric Furnace | Analysis of Fumes from Electric Furnace |
|---|---|---|
| | % | % |
| $SiO_2$ | 17.14 | 23.38 |
| Si | . . | 8.87 |
| Carbon | 17.18 | 19.30 |
| $Fe_2O_3$ | 9.46 | 2.26 |
| $Al_2O_3$ | 6.36 | 6.54 |
| Mn | 38.16 | 18.72 |
| CaO | 1.40 | 4.56 |
| MgO | 5.28 | 15.50 |
| Phosphorus, As | 0.13 | . . . |

Such was the environment in which were employed the two workmen whose histories are given below.

CASE 1. *History.* — N. V., an Italian, 25 years old, was examined first on Feb. 1, 1916, and subsequently at various times during the early months of that year. He gave the history of always being well and never having had any accidents or injuries or bad habits. He did not drink or smoke. He had been in this country ten years. He had been married four years; his wife had been previously married but had never had any children. He began working for the Steel Company on Sept. 25, 1912, as a laborer, and continued as a laborer until Feb. 16, 1914, when he was transferred to work as a charger at the electric furnace where ferro-manganese was fused before it was added to the converter to make manganese steel. He continued in this work until the time of examination when his foreman found it necessary to change his employment on account of increasing mental dullness.

Conversation with the patient and his wife brought out the facts that early in October, 1915 he began to be sleepy and indifferent, and that during Christmas week he took no interest in the festivities, which he had greatly enjoyed in previous years. Shortly after Christmas his wife noticed that he was often tremulous, especially at the table, that this condition persisted during sleep, and that he was rather disposed to stagger on his feet as though he were

drunk. Moreover, about the same time he would walk backwards and occasionally would fall backwards. Two or three times in succession, while trying to put up some window shades, he lost his balance, finally falling backwards to the floor.

Sometimes his wife noticed that his face was very red, and she said that it looked different — meaning that his expression was different. She also noticed that he would laugh frequently without any apparent cause, contrary to his former way of doing. Sometimes he would laugh at whatever was said to him. She noticed, too, that he had difficulty in coughing and that he did not seem to be able to cough up the accumulations in his throat.

The patient complained of weakness in his hands and legs since Christmas of 1915, and noticed that when going downstairs his legs trembled and he felt insecure. He always staggered backwards when he lost his balance. He made no complaint of loss of sphincter control or of sexual disability.

His wife said that his memory was all right. She noticed that his neck gradually became larger and that, although formerly he had worn a size 15 collar with comfort, a number 16 now seemed rather tight for him. He did not complain of headache, and his appetite remained good and his bowels were regular. She stated that at times his speech was normal but that often it was necessary to ask a question several times and even to speak sharply before an answer was obtained. She also noticed that in friendly scuffles she was stronger than her husband, whereas formerly the reverse was true. His disposition, she said, was becoming ugly and he had attacks of violent temper which were quite short in duration. In one of these fits of anger he threw a piece of soap at her, striking her side and bruising it. Immediately after this he showed that he was sorry that he had hurt her.

*Examination of Patient.* — The patient was a very strong muscled, thick-set Italian. His face was expressionless and mask-like. (Figure 2.) Over the nose and each cheek, somewhat in the common distribution of lupus, there was distinct erythema, which whitened to finger pressure, and on the left cheek there was some scaliness. He closed his eyes, moved all his facial muscles, protruded his tongue in the middle line, and the tongue was not tremulous. He held his lips firmly under expiratory effort. He gave a short whistle but no longer whistled continuously as he had been in the habit of doing. He had difficulty, apparently, in taking a deep inspiration; repeated efforts failed of the desired result, and during the examination he seemed to be disturbed at times with an accumulation of mucus in his throat. Finger to nose test was accurate but irregularly tremulous. The patient stood well with his eyes closed, but not so well on his left foot as on his right. He walked in a rather uncertain fashion, though not in a definitely atypical way. Reflexes were normal throughout.

The patient signed his name and wrote his street number with comparative readiness, but his writing

FIG. 2. (Case 1.) Showing the characteristic expressionless and mask-like facies.

was cramped and his wife said that it was different from what it used to be. His arterial pressure was 70/92, with a pulse of 80. His tremor was not much exaggerated on volition; he poured water from one test tube to another fairly well. There was no body tremor, no tremor at rest. He articulated every word but not clearly, and his speech was muffled and difficult to understand, seemingly because of the motionless condition of his lips and mouth parts in the effort of speech. At times during the interview

he did a little laughing without its being apropos, and at other times he laughed at something that was said which he may have considered amusing (Figure 3). Voluntary strength and grasp and resistive movements at the elbow and shoulder and in the

FIG. 3. — (Case 1.) Unmotive laughter was a prominent symptom in this case.

lower extremity seemed to be very great, in spite of his complaints of weakness.

During the examination the patient stepped off the scales backward and was unable to stop until he had walked backward to the opposite wall, a distance of about 12 feet. Then it was noted that if he were given a slight push in a backward direction he would walk back several steps before recovering his balance. He expressed no sense of fear of falling and smiled as he walked back.

While the patient was in the hospital for observation it was noted that he slept a great deal during the day as well as at night. His pulse, temperature and respirations were normal.

An X-ray examination failed to reveal any pathology in the lungs or gastro-intestinal tract. His urine was normal. His feces and urine were examined for traces of manganese, but none was found. A Wassermann test on the patient's blood gave a frank negative reaction. Blood examination showed hemoglobin 85 per cent., white cells 7,250, red count 5,640,000. As a probable explanation of this unusually high erythrocyte count, it should be understood that there was added to the ferro-manganese at intervals a certain amount of limestone and coke, and it is possible that there was a sufficient amount of carbon monoxide given off from this coke — there being no air supply to the interior of the furnace — to produce a mild form of carbon monoxide poisoning.

CASE 2. *History.* — S. K., a Hungarian, aged 32, a married man, without children, had been in the employment of the Steel Company since Feb. 17, 1906, but he was laid off on account of lack of employment on March 6, 1908, and he returned to work on Oct. 20, 1908. During this time he was employed as a runner in the converter until May 7, 1913, when he became a weigher at the electric furnace, weighing the manganese in the ladle as it was poured from the furnace. He was doing this work until the latter part of 1915, when he found that he was unable to continue. On Jan. 31, 1916, Mr. S., the superintendent of the Bessemer department, stated that this man had for some time past been a very able and efficient workman but that he had noticed a gradual decrease in his energy and mental acuteness, and had thought that he was becoming lazy. Mr. S. said that the man seemed to be dull mentally and that his movements were sluggish, and that when asked why his work was so poor he responded that he did not know, and seemed indifferent.

This patient was examined first on Feb. 1, 1916, and has been under observation at various times since. When questioned, he stated that he never had any serious illness, accidents, or dissipated habits. A little over a year before the first examination, he began to notice that he was having some difficulty in walking — a tendency to trot forward or backward when first starting off, and a little trouble in going down hill or downstairs. He had no feelings of dizziness, however. He said also that he had some numbness in his fingers and his toes. About this time his speech became muffled and indistinct. He became weak, and had continued so up to the time of examination.

*Examination of Patient.* — At the time of the first examination, the patient presented a peculiar facial

expression, a mask-like face (Figure 4), commonly with the contours and appearance of a fixed smile which showed his teeth. This was not invariable, but was frequently present and tended to be rather persistent. He walked fairly well, but said that he had an inclination to hurry ahead and he did, as a matter of fact, walk with rather short, hastening steps. He also indicated that at times he ran backwards. He said that he slept well, had a good appetite, good digestion, good bowel action, entire control of the bladder, and a reasonable amount of sexual ability. He said that he had no sensory disturbance, but his hands were cold and cyanotic, and the nutrition of the cuticle about the nails did not seem to be good — that is, there was a suggestion of glossiness about the skin.

Fig. 4. — (Case 2.) This patient presented a peculiar facial expression, mask-like face, with the appearance of a slight, continual, fixed smile.

Cranial nerves seemed to be all normal as to voluntary control and as far as reflexes were concerned. The deep reflexes were also all present and about normal, certainly not at all exaggerated. This was true of heel jerks, knee jerks, wrist and elbow jerks.

Fig. 5. — (Case 2.) Unmotive laughter was a prominent symptom in this case also.

The patient's writing was small and cramped and attempts to write a larger script even with a pencil failed. He wrote, however, with readiness and even with a fair amount of speed for a laboring man. He said that he could read and write but that he did not spend any time in reading. His speech was particularly peculiar. He talked with lips slightly retracted and motionless, teeth almost together, tongue apparently immobile, and his voice was low and monotonous, the enunciation deliberate and obscured. He tended to answer in monosyllables, and

seemed to have great difficulty in formulating a sentence. When asked how long he had worked on the furnace, he undertook to say that he had worked two years and eight months, and after a long pause one could understand the "two," and he drawled "aaaa" for a long time until it seemed that it would be impossible for him to enunciate anything at all, and at the end of a continuous drawling "a," dropped out "eight months" rather abruptly. It was impossible to understand him when he attempted to explain anything, and anything besides "yes" and "no" could be understood only with considerable uncertainty and guessing, yet he seemed mentally clear though apathetic.

No decided tremor was observable, but upon having the patient extend his fingers one could see and feel a tremulousness in the hands and arms, with some lack of co-ordinate control of the phalanges of the fingers. He poured water from one tube to another with steadiness and precision. He made all sorts of indicated voluntary movements with readiness. His grasp was greatly weakened in both hands, and his ability to resist passive movements communicated to his arms, especially at the elbows by the contraction of the biceps, was reduced. The leg muscles also seemed somewhat weakened. The eye grounds were normal.

Examination of the blood showed hemoglobin 90 per cent., leukocytes 8,000, erythrocytes 6,400,000. This unusually high red cell count was the result of a mild form of carbon monoxide poisoning, the explanation of which is noted in the preceding case. A Wassermann examination of the blood was negative. A chemical analysis of the urine and feces showed no trace of manganese. The urine examination was otherwise negative. An X-ray examination of the lungs showed no evidence of manganese infiltration. The patient's temperature, pulse and respirations were normal. A tendency to sleep and unmotive laughter were marked symptoms (Figure 5).

In May, 1917, it was noted that there was a marked falling out of the patient's hair, and on the right side along the hair line above and behind the right ear for a length of 5 inches, there was an area about 1 inch wide which was entirely denuded of hair. The hair in other parts of the scalp was easily removed by slight pulling.

The diagnosis of chronic manganese poisoning in these two cases was first made by Dr. Huey. The neurological examinations were later made by Dr. Archibald Church who confirmed the diagnosis.

The operation of the electric furnace, which was used to melt the manganese compounds, was discontinued when it was established that these men were suffering from chronic manganese poisoning. This was done because no practical way was found to eliminate entirely the dust and fumes from the furnace when it was in operation.

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# TRINITROTOLUENE POISONING — ITS NATURE, DIAGNOSIS, AND PREVENTION *

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## Introduction

With the entrance of the United States into the World War, the prevention of poisoning among American munition workers presented a public health problem of considerable importance. Previous experience in other countries had demonstrated that the productiveness of munition plants was dependent, to a large extent, on the prevention of such poisoning. Protection of the health of thousands of workers engaged in this industry was also a matter of much concern. Our allies, Great Britain in particular, had fortunately given this matter serious thought and considerable scientific work had been done with a view to reducing the health hazards in munition plants.

The most important explosives used for the manufacture of shells belong to the group of nitro derivatives of aromatic hydrocarbons, aniline and phenol. Among these nitro-compounds, trinitrotoluene (commonly called T.N.T., triton, or trotyl) was predominantly used in this country and in England on a very large scale. Inasmuch as the experience with this explosive in Great Britain had called attention to the serious health hazards connected with its manufacture, and especially its handling in the filling of high explosive shells, there appeared soon after the entry of the United States into the war several articles dealing with this subject.

In the Public Health Report of Nov. 16, 1917, Surgeon J. W. Schereschewsky (1), of the United States Public Health Service, gave an exposé of the practical aspects of the problem as ascertained by an inspection of the plants where T.N.T. was manufactured or used in the filling of shells. W. G. Hudson (2) (3), medical director of the Du Pont Company, and Alice Hamilton (4), of the United States Department of Labor, also contributed papers dealing with T.N.T. poisoning in factories in this country. H. S. Martland (5) described the first fatal case of T.N.T. poisoning which had occurred in the United States.

Although no accurate statistics were available on the incidence of T.N.T. poisoning in this country, inspection of various factories engaged in this industry had shown that the health of a considerable number of workers was affected by the constant contact with T.N.T. Being charged by Congress with the safeguarding of the health of the civil population, it became the duty of the United States Public Health Service to undertake an investigation of the best ways and means for the prevention of T.N.T. poisoning, inasmuch as it was evident that the available information was not adequate enough to lay down safe rules for this purpose. For instance, no satisfactory data were known as to the production and characteristics of T.N.T. poisoning in animals, data which were obviously needed to serve as a firm basis for the understanding of the nature, diagnosis, and prevention of T.N.T. poisoning in man. Accurate observations were also lacking in regard to the degree of contamination of factory air with T.N.T. under various conditions, data which are essential for purposes of proper ventilation of these plants. For these reasons the Hygienic Laboratory undertook a co-operative investigation, the Division of Chemistry concerning itself with (1) the

* The details and the methods used in this investigation will be found in Hygienic Laboratory Bulletin No. 126. Received for publication Sept. 21, 1921.

determination of the vapor pressure of T.N.T. at various temperatures and the amount of T.N.T. present in the air of various parts of a shell-filling plant, and (2) the quantitative determination of T.N.T. or its derivatives in the urine. The Division of Pharmacology was charged with the study of the pharmacological aspects of the problem, with particular reference to (1) the elaboration of reliable and simple tests for the diagnosis of mild poisoning, (2) the investigation of the channels of absorption to the poison by the animal body, (3) the discovery of prophylactic methods, etc. It was in the nature of the problem that the practical aspects dealing with the recognition and prevention of T.N.T. poisoning should receive the major attention, although a number of very interesting observations were made which, as will be seen, have an important bearing on the subject of blood destruction and regeneration.

The data included in this report deal with the work done by the Division of Pharmacology. They are divided into two parts, the first one dealing with experimental T.N.T. poisoning as produced in dogs, and the second with the investigation of T.N.T. poisoning in a large shell-filling plant. The results obtained by the Division of Chemistry will be published elsewhere.

## Experimental T.N.T. Poisoning in Animals

As previously stated, the literature contains little satisfactory information concerning the production of typical T.N.T. poisoning in animals. White and Hay (6), on the basis of a few experiments on cats and rabbits, considered T.N.T. "as not poisonous under ordinary use." Moore, Webster, and Wyon (7) state that they were not successful in producing toxic symptoms in guinea-pigs exposed for several weeks to T.N.T. fumes in factories, whereas kittens under similar conditions showed evidence of poisoning (cyanosis). The animal work of these investigators was largely confined to rabbits and guinea-pigs, which were given one or a few large doses, ranging from 10 to 9,000 mg. per kilo body weight. The British report, while containing extremely valuable information, does not include any really satisfactory information on T.N.T. poisoning in animals. This is due to the fact that the species of animals selected for the work happened to be highly resistant to the toxic action of T.N.T. It is, of course, possible to kill even a highly resistant animal with massive doses of the poison, but it is questionable as to whether the symptoms and pathological changes thus produced correspond to those found in T.N.T. workers who, according to clinical observers, must be exposed to T.N.T. for at least four weeks.

During the progress of our work a brief abstract of the work of Kramer and Meierhof (8) appeared, in which these authors reported some experiments dealing with T.N.T. poison in dogs. They noted the following symptoms: vomiting, diarrhea, depression, and weakness. Examination of the blood revealed the presence of a leukocytosis, polychromasia, and an increase in nucleated red blood cells. The necropsy findings were negative, with the exception of a moderate degree of central degeneration in the liver and an increase of blood pigment in the bone marrow, lymph nodes, and spleen. They called attention to the absence of any lesions which might explain the death of the animals, particularly the absence of acute yellow atrophy of the liver.

It was therefore necessary to find a highly susceptible animal.

### *General Plan of Investigation*

Preliminary experiments with guinea-pigs and albino rats confirmed the previously noted statements of the British

investigators that these animals are highly resistant to T.N.T. That the animals absorbed the poison was evident from the change in the color of the urine and the positive Webster test. In rats the urine contains a bright pink pigment after T.N.T. is given either by mouth or subcutaneously. The first few experiments with dogs and cats, however, showed that these animals develop the typical symptoms which are seen in T.N.T poisoning in man. Dogs were finally chosen for this investigation as these animals seemed to be sensitive to T.N.T. and as they were of sufficiently large size to permit the frequent withdrawal of small quantities of blood for examination.

In view of the fact that T.N.T. poisoning in munition workers is essentially of a chronic nature requiring several weeks or even months for its full development, it was desirable to produce an analogous condition in dogs by the repeated administration of relatively small doses of T.N.T. over a long period of time. A small number of experiments dealt with a study of acute poisoning. For this purpose a single large dose (100 mg. per kilo) of the poison was given.

For the production of chronic poisoning the doses ranged from 5 to 33 mg. per kilo body weight given every day except on Sundays and holidays. The T.N.T. used in this investigation was obtained from various shell-filling plants and represented a product of average purity. A chemically pure T.N.T. was prepared for us by Dr. Marcus of this laboratory. In most of the experiments the poison was administered either by mouth in the form of gelatin capsules or subcutaneously dissolved in olive oil. A small number of animals received the T.N.T. in the form of fine dust directly into the lower air passages. For this purpose the animals were anesthetized. A small catheter was inserted through the trachea into the left bronchus and the fine T.N.T. dust was then blown into the lungs, this being followed by the immediate withdrawal of the catheter, care being taken that none of the poison should come into contact with the animal's mouth. A few animals received the poison dissolved in oil intraperitoneally.

The condition of the animals was carefully watched and the kind and severity of symptoms observed were recorded daily. A specimen of urine was secured each day (except Sundays) by means of catheterization, and these urines were submitted to various tests for the presence of abnormal constituents, such as sugar, protein, bile pigment, and T.N.T. and its derivatives.

Particular attention was also paid to changes in the blood in this condition. For this purpose the blood of each animal was carefully examined prior to and following the administration of the poison. In a considerable number of the animals a complete blood study was made, including a quantitative estimation of the hemoglobin, the total blood volume, plasma volume, and pigment volume, the number and character of the red cells, a leukocyte and differential count, the number of reticulated and nucleated red cells, the coagulation time of the blood, and the presence or absence of bile pigments and T.N.T. derivatives in the serum.

In view of the fact that the work of Hunt (9), of Opie and Alford (10), and of Salant and Swanson (11) had shown that the character of the diet has a marked influence on the toxicity of various substances, and as Hooper and Whipple (12) had demonstrated that blood regeneration is materially influenced by the composition of the diet, it seemed important to study the effect of various diets on the course of the T.N.T. poisoning. Three diets were chosen for this purpose: (1) a bread and milk diet, composed of approximately equal parts per weight of pasteurized milk and white bread; (2) a meat diet, consisting of medium fat beef with or without the

addition of calcium phosphate; and (3) a mixed diet containing white bread, pasteurized milk, and medium fat beef in the proportion of 3, 3 to 1. The relative proportions of protein, fat, and carbohydrates in these three diets were as follows:

| | Protein | Fat | Carbohydrate |
|---|---|---|---|
| Bread and milk | 15 | 7 | 78 |
| Mixed........ | 20 | 14 | 66 |
| Meat........ | 45 | 65 | 0 |

These figures show that the bread and milk diet is rich in carbohydrates and relatively poor in fats and proteins. The meat diet, on the other hand, is rich in fat and protein, and the mixed diet occupies an intermediate position.

Inasmuch as the British report had called attention to the probable conversion of T.N.T. within the body into certain reduced compounds, particularly a hydroxylamine derivative, a number of reduction and oxidation products of T.N.T. were prepared, and their pharmacological action compared with that of T.N.T. The solubility of these compounds in oil and water was also determined. This phase of the work is of interest with respect to its bearing on the fate of T.N.T. in the body and the mechanism of the toxic action of the substance on the tissues and particularly the red blood corpuscles. A careful necropsy was made on all animals which died and all the tissues, with the exception of the central nervous system, were subjected to histological examination.

*Explanation of Charts.*—The charts and their legends contain the essential information relating to and the results obtained by the experiments. The number and time of administration of the doses of T.N.T. are indicated by the arrows at the bottom of the charts. The figures immediately above represent the number of nucleated red cells per 200 white cells counted. The curves were obtained by plotting the initial value obtained before the animal received T.N.T. as 100 per cent. The curves therefore represent the percentage fluctuations and give a clear picture of the course of the poisoning as determined by the body weight and the blood changes.

*Discussion*

(*a*) *Symptomatology.*—In munition workers various symptoms, such as dermatitis, gastro-intestinal pain, constipation, bleeding from the nose, giddiness, cyanosis, breathlessness after slight exertion, anemia, and jaundice, have been attributed to the toxic action of T.N.T. The symptom-complex varies with the individual. In the milder form of poisoning, which is spoken of as "minor T.N.T. sickness," there may be present cyanosis, dermatitis, nose bleeding, constipation and giddiness. The severer forms of poisoning have been divided into toxic jaundice and aplastic anemia.

Doses of T.N.T. ranging from 5 mg. to 100 mg. per kilo body weight produced a more or less severe grade of intoxication, the severity of the latter being somewhat dependent on the size of the dose. After the larger doses the animals showed marked symptoms within a few hours, whereas the lowest dose used (5 mg. per kilo) did not always lead to recognizable clinical manifestations.

The striking feature of T.N.T. poisoning in dogs is the fact that *individual susceptibility* plays a very important part. Certain animals receiving a fairly large dose may not show as marked symptoms as others receiving 50 to 75 per cent. less T.N.T. This difference in individual susceptibility is very probably not due to differences in the rate of absorption of the poison, as T.N.T. is absorbed fairly rapidly. It is more likely that different individuals deal differently with the poison after the poison is absorbed, a point which will be dealt with later on.

Most of the animals developed within the first day after the administration of the T.N.T. a very pronounced *cyanosis*, a

symptom which is very common in T.N.T. workers. The mucous membrane and tongue of the dogs assumed a dark purplish color. This cyanosis was observed in some dogs as early as four hours after the administration of a fairly large dose. In a few animals which had received one large dose or repeated small doses this symptom was entirely lacking, in spite of the fact that these animals finally died from the effects of the poison. In animals receiving the poison over a long period of time the cyanosis usually cleared up after the first two weeks, giving place to an anemic appearance of the mucous membranes. At its height the cyanosis may be associated with a marked dyspnea, and the blood always contains considerable methemoglobin and is chocolate-brown in color. Oxygen inhalation has no effect whatever on the cyanosis, a fact which proves that the latter is essentially due to the large amounts of methemoglobin of the blood.* It is, however, possible to lower the increased pulse rate and respiration observed in this condition by allowing the animal to breathe a mixture of air and oxygen.

In some of the experiments a very marked *incoordination* was noted, which first appeared on the second or third day. When this occurs, the animal staggers and is apt to fall when attempting to walk downstairs. The incoordination is usually associated with a marked cyanosis and disappears in the later stages in chronic poisoning. It appears as if this symptom is due to a temporary functional abnormality of the cerebellar centers.

*Vomiting* and *salivation* were observed in a number of animals during the stage of acute intoxication. *Constipation* was sometimes noted, though as a rule the animals suffered from *diarrhea*. The *body weight* and nutrition were maintained in a satisfactory manner in a considerable number of experiments of long duration.

All animals developed an *anemia*, the principal features of which, and its causation, will be discussed separately. In six dogs a *marked icterus* was observed, this being preceded by the excretion of a considerable amount of bile pigment with the urine. Dermatitis occurs in T.N.T. workers, but was never observed in these animals. Ulceration of the mucous membrane, which was observed in the dogs on a bread and milk diet, has no relation to T.N.T. poisoning, but is due to a dietary defect.

(*b*) *Paths of Absorption of T.N.T.* — From a practical point of view it was important to determine by what channels T.N.T. can gain access to the blood and tissues. Under the conditions prevailing in the factories, the T.N.T. workers may come into contact with both T.N.T. vapor and dust, thus exposing the skin and the respiratory and gastro-intestinal tracts to the poison. It was, therefore, necessary to determine whether these organs absorbed T.N.T.

Experiments which are not reported in detail have shown that dogs and cats which had received T.N.T. dust directly into the lower air passages developed a marked cyanosis within twelve hours, and their urine revealed the presence of a T.N.T. derivative. T.N.T. is evidently very readily absorbed by the epithelial cells of the bronchi. On account of the probability of producing a pneumonia by this method of administration, no attempts were made to cause chronic poisoning in this way.

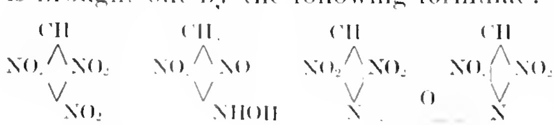
T.N.T. is also very readily absorbed from the gastro-intestinal tract when it is given in the form of gelatin capsules. As T.N.T. is very readily soluble in fat, it might be expected that fat would favor its absorption. The comparison of the results obtained in animals fed either on a diet

* This methemoglobin formation is due to the reduction of T.N.T. to a hydroxylamine derivative, the latter acting on the hemoglobin. Letsche (13) in *Ztschr. f. physiol. Chem.*, 1912, Vol. 80, p. 419, has shown that hydroxylamine converts oxyhemoglobin completely into methemoglobin.

poor in fat (bread and milk) or on a fat-rich diet (fat meat), however, shows that the presence of a considerable amount of fat in the food does not favor the absorption in any way. Within six hours after the feeding of T.N.T., the urine yields a positive test for the presence of a T.N.T. derivative (Webster test), and cyanosis, incoordination and dyspnea are observed.

The poison is also absorbed with great ease when injected subcutaneously in the form of a 3 per cent. solution in olive oil. These injections, even when repeated daily over several weeks, do not seem to lead to any local irritation at the site of injection. Kramer and Meierhof (8) state that they have been able to produce T.N.T. poisoning in dogs with great regularity by means of skin inunction. We have not used this method, principally on account of the impossibility of ascertaining the amount of T.N.T. actually absorbed. T.N.T. is also readily absorbed from the peritoneal cavity. In conclusion, it is safe to say that T.N.T. is readily absorbed from the respiratory and gastro-intestinal tracts, the subcutaneous tissue, the peritoneal cavity, and the intact skin.

(*c*) *Fate of T.N.T. in Body.*—Moore and his associates of the British Medical Research Committee (7) briefly state in their report that T.N.T. is reduced, within the animal body, to 2, 6-dinitro-4-hydroxylaminotoluene, which is readily converted into 2, 6-dinitro-4-azoxytoluene. The chemical relation of these three compounds is brought out by the following formulae:



The hydroxylamine derivative is then conjugated with glycuronic acid and excreted in this form in the urine. Although the announced paper on this subject has not appeared up to this date,* it seemed of considerable interest to consider this question of the fate of T.N.T. From previous work on the metabolism products of toluene and aromatic nitro-compounds, it is *a priori* possible that both oxidation and reduction might play a rôle in the modification of T.N.T. According to Nencki and Giacosa (14) toluene is oxidized in the body to benzoic acid. Jaffe (15) isolated from the urine of dogs which had received large doses of paranitrotoluene a substance which he identified as paranitrobenzoic acid, part of which was conjugated with glycocoll to nitrohippuric acid. Meyer (16) was able to isolate paraaminophenol from the urine of a case of nitrobenzene poisoning. He also confirms some older observations of Lewin (17), who claims that azoxybenzene occurs in the urine of animals poisoned with phenylhydroxylamine. Walko (18) reports experiments which indicate that picric acid is reduced in the body to picramic acid.

That trinitrotoluene does not occur as such in the urine of T.N.T. workers was shown by Moore and confirmed by us in the case of the urine of dogs poisoned with T.N.T. The so-called Webster test, which is used for this purpose, is based on the fact that an ethereal solution of T.N.T. assumes a purplish-red color after the addition of an alcoholic solution of potassium hydroxide. This test is always negative in the dog's urine if the fresh urine is directly extracted with ether. According to Webster it is essential to acidify the urine with 20 per cent. sulphuric acid before the ether extraction. The ether extract so obtained then yields a dark purplish-red color upon the addition of an alcoholic potash solution. When carried out in this latter way, the test is usually positive in the extract obtained from the urine of dogs which have received T.N.T., indicating that unchanged T.N.T. is absent, but that a derivative giving the same test is present. This derivative, according to Moore, is the above-

* See British Medical Research Council, Special Report Series, No. 58, 1921.

mentioned hydroxylamine compound which has to be split off from its combination with gyleuronic acid by the acid treatment. We found that the only derivative of T.N.T. which yields the same color as T.N.T. itself is the hydroxylamine compound. It is, therefore, very probable that the hydroxylamine compound is one of the metabolism products of T.N.T. We have repeatedly examined the feces of our animals for the presence of T.N.T., but have never been able to get a positive Webster test. The bile, however, very often yields positive tests. Here also, as in the case of urine, it is necessary to add acid before carrying out the ether extraction, a fact which indicates that T.N.T. as such is not present and that, therefore, the test is probably due to the hydroxylamine derivative.

As to the quantity of the hydroxylamine compound which is excreted with the urine very little can be said, except that the method described by Elvove (19) when applied to dog's urine accounts for only from 9 to 42 per cent. of the T.N.T. given to the animals.

An important fact which we wish to emphasize particularly is the absence of any relation between the urinary Webster test and the severity of the intoxication, as determined by the clinical symptoms and the grade of the anemia. The data presented in this report conclusively show that the Webster test may be persistently negative in spite of the presence of marked cyanosis and incoordination, and that, on the other hand, it may be strongly positive in animals in which the symptoms are not especially pronounced.

We have also frequently made the observation that during the first month of chronic poisoning the urine of the dog yields a very marked Webster test, but that this test nearly always becomes negative in the later stages of poisoning, and this in spite of the fact that the animal still receives the poison and shows evidence of a progressing anemia. We believe that this is an indication of a change in the disposition of the poison by the body, in the sense that the hydroxylamine compound is further reduced to the mono or diamino derivative of T.N.T., substances which do not give the Webster test but which possess the same pharmacological action as T.N.T.

It is also possible that part of the T.N.T. is oxidized to trinitrobenzoic acid, which would combine with glycocoll to form trinitrohippuric acid. We have been able to show that trinitrobenzoic acid, when given in doses of the same order as those required for the production of T.N.T. poisoning, has no evident effect on dogs. This substance is, to say the least, much less toxic than either T.N.T. or its reduction products. This difference in toxicity of T.N.T. and trinitrobenzoic acid is very likely due to the greater water solubility of the latter, a fact which favors its rapid removal from the body through the kidney. It is quite possible that the difference in the resistance of different individuals to T.N.T. poisoning may be explained by assuming that the more resistant animals oxidize the methyl group of T.N.T. more readily than the more susceptible individuals.

There remains much to be learned about the fate of T.N.T. and other aromatic nitro derivatives in the body. May it suffice here to state that the marked variation in the resistance to the poison may be easily explained on the basis of the assumption that the reactions involved in the transformation of T.N.T. in the body may differ both qualitatively and quantitatively in different animals of the same and different species.

Trinitrotoluene or some of its derivatives are retained in the tissues for a considerable time, as shown by the progressive anemia observed in dogs after a single dose of the poison and the slow recovery after the animal is taken off T.N.T. This retention of T.N.T. or its reduction products is

probably due to the fact that these compounds are very insoluble in water, rendering their elimination with the urine difficult.

(*d*) *Necropsy Findings.* — All of the animals that died from chronic T.N.T. poisoning were anemic and showed the following characteristic pathological changes which must be attributed to the action of this poison:

The endothelial phagocytes of the spleen pulp, bone marrow, and liver contained engulfed red cells and a varying amount of granular hemosiderin. These pigment granules were frequently as large as red corpuscles. The pigmentation was most striking in the spleen and bone marrow. (Fig. 1.) The liver pigment was usually confined to the swollen Kupffer cells within the liver capillaries. At times groups of hemosiderin-containing phagocytes were found about the portal spaces. The liver cells rarely contained even a small amount

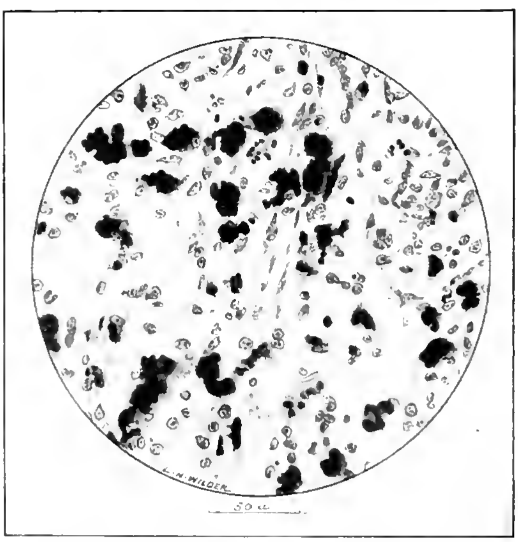


Fig. 1. — Spleen pulp in chronic poisoning containing maximum amount of hemosiderin. Perl's reaction.

of finely granular hemosiderin. (Fig. 2.) The mesenteric lymph glands occasionally contained a few hemosiderin-holding phagocytes.

A mild icterus was found in six of the thirty-nine animals. In these cases the subcutaneous fat and the intima of the aorta yielded a positive test for bile pigment.

A myeline degeneration of the sciatic nerve occurred in the majority of the animals in which this nerve was examined histologically, irrespective of diet.

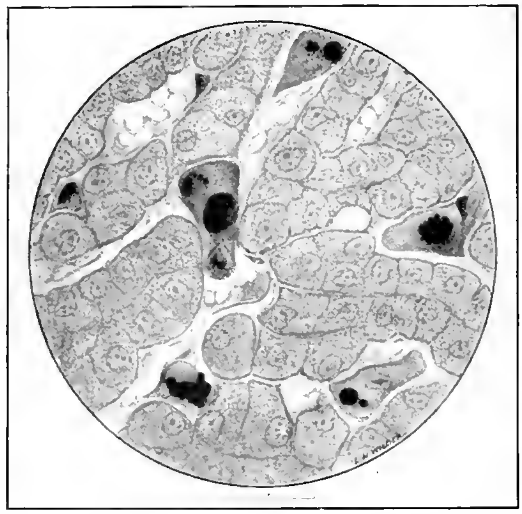


Fig. 2. — Liver in chronic poisoning showing the hemosiderin in the swollen Kupffer cells within the liver capillaries. The liver cells do not contain hemosiderin. Perl's reaction.

In some of the dogs fed on medium fat beef the liver showed a definite fatty change chiefly confined to the liver cells surrounding the efferent veins. Hyaline necrosis was not found, although in a few cases small areas of focal necrosis were detected.

Animals sacrificed within a few days after administration of relatively large doses of T.N.T. showed a varying degree of splenic tumor. In these animals the endothelial phagocytes of the spleen pulp, bone marrow, and the Kupffer cells of the liver contained many engulfed red corpuscles, apparently intact, and a small amount of granular hemosiderin. (See Figs. 3, 4, 5.)

A hyperplastic bone marrow was found in all of the animals except those sacrificed within a few days after the administration of the first dose.

In addition to the above changes a number of the animals with a complicating in-

tercurrent infection showed bronchopneumonia, acute nephritis, cloudy swelling of the liver, and splenic tumor. Two dogs of the mixed diet series and five dogs of the bread and milk diet series showed an extensive superficial ulceration of the oral mucous membrane, changes brought about by the deficient diet and not by T.N.T.

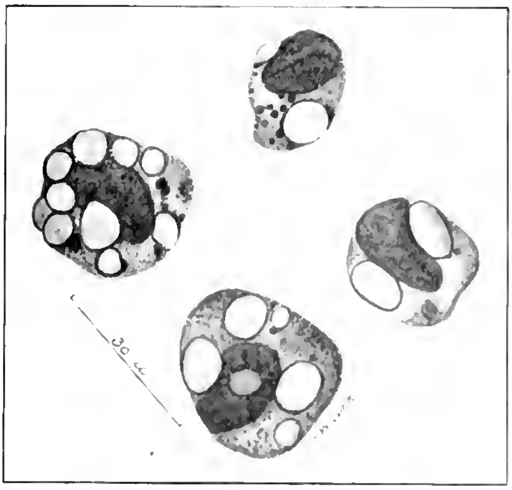



Fig. 3. — Mononuclear phagocytes with engulfed red cells from the spleen pulp in acute poisoning.

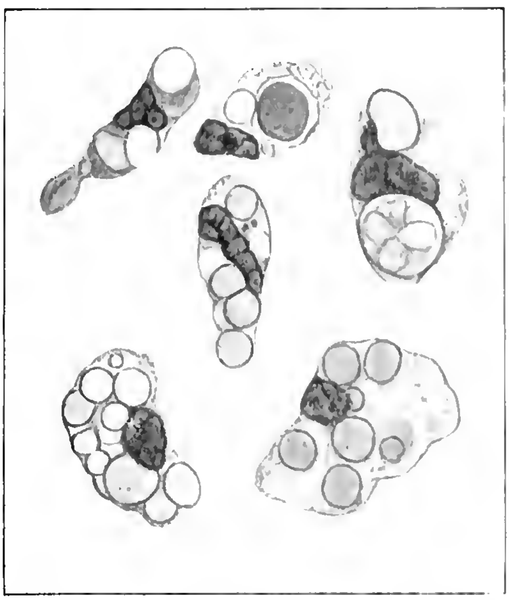


Fig. 4. — Kupffer cells containing red cells and pigment from the liver capillaries in acute poisoning.

(*e*) *Pathogenesis of Anemia and Icterus.* — The salient feature of chronic T.N.T. poisoning in dogs is the anemia so constantly present and the mechanism of this red cell destruction. On reviewing the literature on physiological blood destruction it is evident that a certain proportion of the erythrocytes are continuously broken down and replaced. Ashby (20) showed that the length of life of transfused blood corpuscles in man is thirty days and more. As to the fate of the erythrocytes, present knowledge is still inadequate.

As long ago as 1901, Hunter stated that two different processes of blood destruction may be distinguished — one in which the red corpuscles are phagocytosed without loss of hemoglobin, the other in which the red corpuscles undergo hemolysis with the liberation of hemoglobin within the blood stream. The first process is characterized by a gradual decay of the red corpuscles while still circulating. They become spherical, deeper in color, and retain their hemoglobin until they are enclosed within the active cells of the spleen, or leukocytes of the blood, and are stored up within the spleen or in the capillaries of the liver. Within these cells the whole of the hemoglobin of the corpuscle is converted into

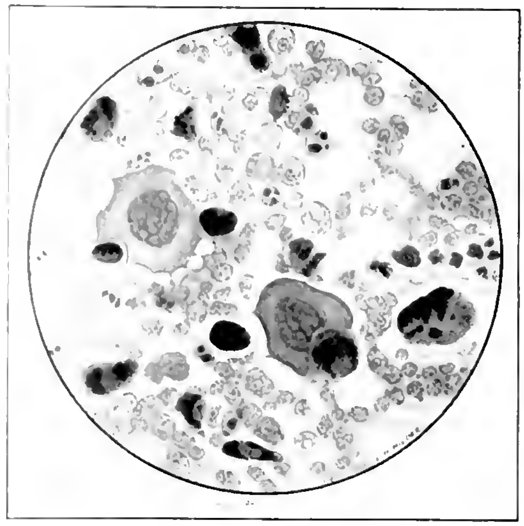


Fig. 5. — Bone marrow in chronic poisoning. Note the amount of hemosiderin within the phagocytic cells. Perl's reaction.

hemosiderin. The pigment so formed is characterized generally by the varying size of its granules, some of which correspond in size to that of the original red corpuscles. In the liver, the pigment is found within the capillaries and never within the liver cells. The second process is marked by the liberation of hemoglobin from the red cell within the blood stream. The hemoglobin escapes from the corpuscle, either alone or in combination with the albuminous stroma. It is carried to the liver and is broken up by the liver cells.

Recently Rous and Robertson (21) showed that a hemolytic process, in the ordinary sense of the term, at most plays a very minor part in normal blood destruction. They state that phagocytosis will not suffice as a general explanation of normal blood destruction and that the red corpuscles, in those species in which phagocytosis is negligible, are fragmented one by one, while still circulating, to a fine hemoglobin-containing dust which is eventually removed from the blood by the spleen, and under exceptional conditions by the bone marrow.

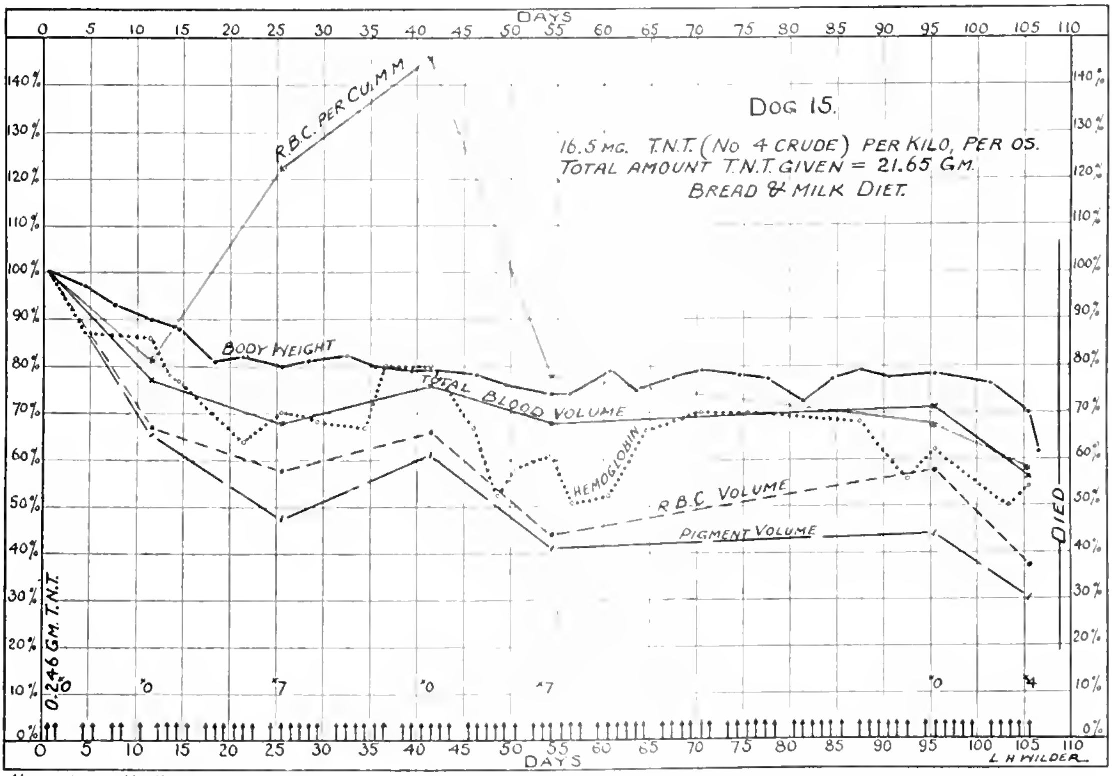
In certain anemias, on the other hand, such as those produced by hemolytic immune serum and by certain poisonous substances (toluylenediamine, sodium oleate, phenylhydrazine, arseniated hydrogen, etc.), the destruction of the red corpuscles takes place by hemolysis within the circulating blood. The hemoglobin escapes from the corpuscles into the plasma and a hemoglobinemia ensues. If the concentration of hemoglobin in the plasma is great enough, it will escape through the kidneys into the urine. The liver cells contain an excess of hemosiderin in consequence of hemolysis, not of phagocytosis of red cells. The hemosiderin granules so arising are small and more or less uniform in size.

According to Pearce, Austin, and Eisenbrey (22), hemoglobin escapes into the urine of normal dogs when the concentration of free hemoglobin in the blood plasma is approximately 0.06 gm. of hemoglobin per kilo of body weight. The blood of the dog contains approximately 16 per cent. of hemoglobin, so that it would require the hemolysis of the red corpuscles contained in only 4 c.c. to cause a hemoglobinemia in an animal weighing 10 kilos.

The anemia produced in dogs by T.N.T. is characterized by a very rapid destruction of the red corpuscles. The percentage of hemoglobin in the unit of blood diminishes. The pigment volume, representing the total amount of hemoglobin in the circulating blood at the time of the blood volume determinations, drops in certain animals to 50 per cent. or less within fifteen days, especially in those on a bread and milk diet. Coinciding with this decrease in pigment volume there is a marked diminution in the total blood volume corresponding roughly to the extent of the reduction of the red blood cell volume. This rapid blood destruction is not accompanied by the appearance of hemoglobin in the blood plasma or urine. In many cases there is also a complete absence of bile pigment in the blood plasma and urine. The number of red corpuscles is usually markedly decreased. In a few cases, however, the erythrocytes have fragmented to such a degree that their actual number per cubic millimeter of blood is considerably increased above normal, while the total pigment volume and red blood cell volume show a very marked decrease. (See Fig. 6.) Fragmentation of red cells has been most marked in dogs on a bread and milk diet. Anisocytosis, poikilocytosis, and polychromatophilia were common findings, the degree of such abnormalities usually corresponding to the degree of the anemia. The detailed examination for disintegrating red corpuscles in dogs acutely poisoned revealed the presence of considerable numbers of these cells in the blood, spleen, bone marrow, and liver. They were often small.

Sometimes they were as large as and even larger than the normal red cell. Most of them were characterized by a translucent blister-like elevation extending from a portion of the cell and having at times a somewhat irregular outline. The hemoglobin mass within these cells stained uniformly and deeper than the surrounding scopic examination. The methemoglobin is confined exclusively within the red corpuscles and does not occur in the plasma.

As stated above, in the necropsy findings, the spleen pulp, bone marrow, and, at times, the mesenteric lymph glands contain numerous large mononuclear phago-




NUMBERS WITH X = NUCLEATED RED CORPUSCLES.

FIG. 6. — Adult male Slight cyanosis, salivation, and incoordination. Food consumption fair. Slight icterus of conjunctivae between the 46th and 65th days and between 88th and 93d days, accompanied by an increase in bile pigments in the urine. Leukocytes varied between 4,200 and 22,400 Reticulated cells 12 to 95 during the first 71 days. Nucleated reds from none to 7. Anisocytosis and basophilia.

*Autopsy.* — Emaciation. Extensive superficial ulceration of oral mucous membranes. Bone marrow hyperplastic. Spleen pulp, liver capillaries, bone marrow, and mesenteric lymph glands contain hemosiderin-holding phagocytes.

*Note the increased fragmentation of erythrocytes between the 12th and 54th days.*

red corpuscles. Other cells were found in which the hemoglobin was apparently divided by a clear portion. (See Fig. 7.) Hemolyzing red corpuscles or red corpuscle shadows were not encountered.

Blood, aspirated from the external jugular vein within a few hours from animals given a moderate dose of T.N.T., is chocolate-brown in color and contains large amounts of methemoglobin on spectro-

cytes loaded with granular hemosiderin — some of the granules are as large as the red corpuscles — and in acute poisoning, especially, the phagocytes contain engulfed red corpuscles. The Kupffer cells of the liver are swollen and contain hemosiderin and red corpuscles. At times there are groups of hemosiderin-containing phagocytes about the portal areas. The liver cells rarely contain hemosiderin.

A further important observation in determining the mechanism of the blood destruction is that T.N.T. does not produce hemolysis *in vitro* when added directly, or dissolved in olive oil, to defibrinated blood, citrated blood, or washed red corpuscles. From these experiments it is evident, however, that T.N.T. is absorbed by the red corpuscles, since part of the oxyhemoglobin is changed into methemoglobin within twenty minutes at 37° C.

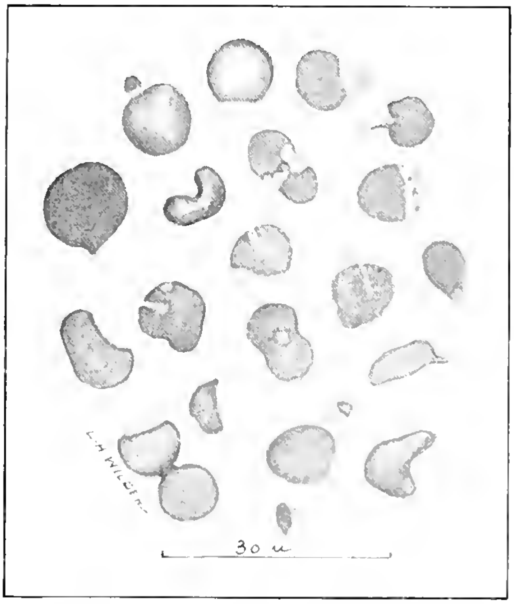



Fig. 7. — Disintegrating red corpuscles from the blood of an acutely poisoned T.N.T. dog. Wright's stain.

On the basis of these observations the following explanation may be made of the mechanism responsible for the blood destruction in T.N.T. poisoning. *T.N.T. or some of its derivatives, being lipoid soluble, are absorbed by the red corpuscles and change part of the oxyhemoglobin into methemoglobin. Disintegration of the red corpuscles follows without the liberation of hemoglobin or methemoglobin into the blood plasma. The injured cells are then engulfed by the endothelial phagocytes of the spleen, of the bone marrow, of the lymph glands, to a certain extent, and by the endothelial Kupffer cells of the liver. The engulfed red cells are in turn broken down within the endothelial phagocytes with the formation of bile pigment and hemosiderin.*

The bile pigment which at times occurs in the urine of dogs poisoned with T.N.T. without the appearance of icterus can be easily explained when it is remembered that the dog's kidney excretes bile pigment very readily and that normally the blood plasma does not contain any bile pigment. A trace of bile pigment in the urine of normal dogs is commonly found, especially when the animals are constipated or during fasting periods. On the other hand, the threshold value of the human kidney for bile pigment is relatively high and plasma contains a considerable amount of bile pigment before it appears in the urine. Gilbert and Herscher (23) showed that the normal human serum contains from 25 to 35 mg. of bilirubin per liter. Panton (24) studied the blood of 100 munition workers exposed to T.N.T. and found that 20 per cent. had an increase of bile pigment in the serum without its appearance in the urine. The increase of bile pigment found at times in the urine of poisoned dogs corresponds to the increase of bile pigment in the plasma of munition workers — probably brought about in either case by the increased destruction of red corpuscles by the endothelial phagocytes and the consequent formation of bile pigment within these phagocytes.

Six dogs out of thirty-nine showed slight but definite clinical *icterus* of the mucous membrane of the mouth and conjunctiva, accompanied by the appearance of bile pigment in the blood plasma and considerable amounts in the urine. In four of these dogs the icterus appeared several days before death. At necropsy the intima of the aorta and the subcutaneous fat were definitely bile stained and gave positive tests for bile pigment. The kidneys in two of the animals were normal. The slight fatty changes occasionally found in the liver can-

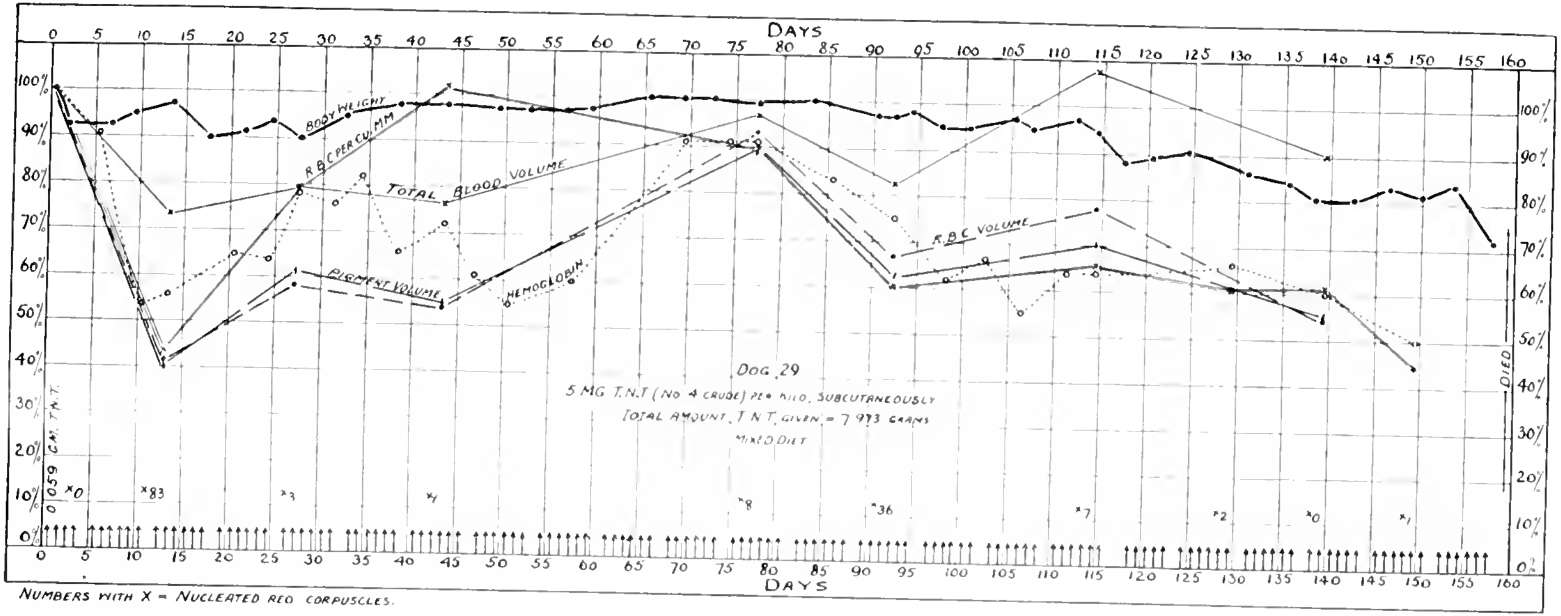



FIG. 8. — Young adult female. Intermittent cyanosis, inco-ordination, and salivation during first part of experiment. No icterus. Food consumption good. Leukocytes 9,000 to 20,600. Reticulated reds 1 to 91 during the first 44 days. Nucleated reds none to 83. Anisocytosis, poikilocytosis, and basophilia.

*Autopsy.* — Oral mucous membrane shows a few superficial ulcerations. Bone marrow hyperplastic. Bone marrow, liver capillaries, and spleen pulp contain numerous phagocytes loaded with coarsely granular hemosiderin. Liver cells are normal.

*Note the rapid destruction of blood during first two weeks, simultaneously with the marked increase of the nucleated reds in the circulating blood (83 to 200 white cells). This period is followed by a gradual regeneration of the blood in the following two months during which time the number of nucleated reds is small (1 to 3). This evident blood regeneration may be due to a compensating hyperactivity of the hematopoietic organs or a period of tolerance during which time the body is able to cope successfully with the poison. Increased blood destruction follows the 80th day, accompanied by an increase in the nucleated red cells. The nucleated reds probably indicate a very active hematopoietic system.*

not be held responsible for the icterus. The bile in all four cases was very dark and viscous. Special attention is called to the transient nature of the icterus observed in two of the dogs. In these animals the icterus coincides with periods of very active blood destruction. Furthermore, five out of the six animals that developed icterus were fed on meat, a diet which stimulates blood regeneration. On this diet the number of red corpuscles formed, and possibly the number undergoing disintegration, is greater than on a bread and milk diet, which, as already pointed out, is not as satisfactory for blood regeneration.

Possibly the icterus of these animals was of an obstructive type and hepatogenous in origin due primarily to the viscid bile which led to obstruction in the smaller bile ducts, with consequent absorption of the bile by the hepatic capillaries and without definite liver injury. Another possibility is a functional disturbance of the liver cells, rendering them incapable of dealing with the bile pigment, as normally

The primary rapid blood destruction observed in the dogs chronically poisoned is followed by an evident *blood regeneration*, as seen by the increase in the number of nucleated and reticulated * red corpuscles in the circulating blood and by a polymorphonuclear leukocytosis in most cases. In some animals blood regeneration temporarily overcame blood destruction, followed by a partial return to normal of the pigment volume and the total blood volume. (See Fig. 8.) Then, unless the T.N.T. was discontinued, a recidivation followed the period of active blood regeneration which was associated with a gradual fall in the pigment volume and a reduction in the number of nucleated and reticulated red corpuscles.

All of the animals which had received the poison up to the time of death invariably showed a hyperplastic bone marrow at necrospy in spite of the presence of a very severe anemia.

(*f*) *Influence of Diet.* — On account of the considerable difference in the individual susceptibility to chronic T.N.T. poisoning, it is rather difficult to determine the exact influence of various diets on this intoxication. The number of experiments which would have to be carried out in order to obtain reliable data on this point would of necessity be very large. For this reason, the results obtained in this investigation, while not absolutely conclusive, are at least highly suggestive. It is seen that the animals on a mixed or meat diet seem to be more resistant than the dogs fed on bread and milk. The animals belonging to this latter group as a rule show a more acute and severer anemia, and die sooner.

(*g*) *Importance of Impurities in Crude T.N.T.* — The T.N.T. used for the manufacture of high explosive shells is not a chemically pure substance, although it is a fairly pure product consisting of approximately 99 per cent. 2, 4, 6 trinitrotoluene (T.N.T.).†

Various writers have attributed the toxic action of T.N.T. to the impurities contained therein, among which may be mentioned traces of $\beta$ and $\gamma$ trinitrotoluene and especially tetranitromethane.

The results reported in this paper clearly demonstrate that there is no qualitative nor quantitative difference in the pharmacological action of the ordinary T.N.T. obtained from shell-filling plants and chemically pure 2, 4, 6 trinitrotoluene. This latter substance was prepared by Dr. Marcus of this laboratory. Dr. Marcus also tried to isolate the impurities, but suc-

* An increased number of reticulated red corpuscles in the circulating blood is considered by Vogel and McCurdy (25), Lee, Minot, and Vincent (26), and Robertson (27) to be very good evidence of increased activity of the erythroblastic system.

† For literature relating to the manufacture of T.N.T., the reader is referred to Arthur Marshall's "Explosives," J. & A. Churchill, London, England; and G. Smith's "T.N.T. Manufacture," New York, Van Nostrand Company, 1918.

ceeded only in obtaining a few milligrams of $\beta$ trinitrotoluene from 785 gm. of the commercial product. The fact is, therefore, well established that the toxic action of the commercial product is essentially due to 2, 4, 6 trinitrotoluene.

*Summary*

The results obtained in this work may be briefly summed up as follows:

A condition may be produced in dogs which in the most essential respects very closely resembles T.N.T. poisoning in the human. The symptoms observed are cyanosis, methemoglobinemia, choluria, dyspnea, inco-ordination, and salivation. An anemia appeared in all animals and in six a definite icterus was noted. The blood destruction is due to an injury of the red blood corpuscles leading to increased phagocytosis of these cells in the spleen, liver, and bone marrow (phagocytic anemia). Blood regeneration usually proceeds very slowly after the withdrawal of the poison. The icterus is caused primarily by the enormously increased breakdown of hemoglobin within the phagocytic cells of certain organs and in this respect is hematogenous in origin. Acute yellow atrophy of the liver was never observed in any of the animals.

The toxic action of T.N.T. is essentially due to 2, 4, 6 trinitrotoluene. T.N.T. is changed in the body and is not excreted as such. Reduction and oxidation may take part in this transformation. The reduction products have the same pharmacological action as T.N.T. Trinitrobenzoic acid, the only oxidation product studied, is much less toxic than either T.N.T. or its reduction products. A marked variation in individual and species susceptibility was observed, which is probably dependent on the nature of the change undergone by T.N.T. in the body. A definite tolerance to the poison was never established.

The composition of the diet seems to be a factor influencing the susceptibility of the animals to T.N.T. poisoning.

(*To be continued*)

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# BOOK REVIEWS

**The Human Motor or the Scientific Foundations of Labor and Industry.** By Jules Amar, D.Sc., Director of the Research Laboratory of Industrial Labour at the Conservatoire National des Arts et Métiers, Paris. Translated by Elsie P. Butterworth and George E. Wright. Cloth. Pp. 470 with illustrations and index. London: George Routledge & Sons, Ltd.; New York: E. P. Dutton & Company, 1920.

Before the publication of the present volume in English, Amar's work had already become well-known in this country through his *Physiology of Industrial Organization and the Reemployment of the Disabled*, which appeared in 1919, and in which frequent references were made to his more fundamental work, *The Human Motor*. The present volume is thus received with great interest.

Since the book is addressed to the practical man in industry as well as to the investigator, the author's wisdom is at once evident in beginning with a consideration of the general principles of mechanics most obviously concerned in the movement and work of the human machine. In the subsequent chapters which comprise the first part of the book, the following subjects are considered: the structure of the body; neuromuscular action and the energy exchanges in rest and work, and the relation of diet thereto; human energy, including the consideration of speeds, loads, and effort; fatigue; the internal environment and the physicochemical conditions within the body; and external environment. The second half of the book is devoted to experimental methods of measurement applicable to industrial labor and to the results that have been obtained by these methods.

There is sufficient reason for devoting a large section of the volume to general physical and physiological principles as a matter of convenience for the general reader. Opportunity may thus be taken to emphasize aspects of the subject more directly related to industrial physiology. Amar's treatment of general physiolog-

ical matters bearing upon work is stimulating and suggestive, but it is questionable whether the general reader would obtain an adequate conception of the subject in such a brief treatment.

Any reviewer would perhaps find objections to some views of any writer upon the general subject of physiology, and it should not, therefore, detract from the merit of the work as a whole to criticize certain statements and conceptions. The work quoted on the systolic blood pressure for the different ages does not agree with the general views at the present time as regards normal blood pressure, the average pressure for the ages between 20 and 40 being given by Amar as 170–190 mm. Hg.

As to the chemical phenomena occurring in fatigue, the statements that toxins are produced in the muscle, and that "the blood by circulating more quickly during work washes the poisons out of the tissues and carries them to the suprarenal glands which secrete adrenalin by which they are neutralized; it oxidizes them itself by the oxygen which it contains," do not represent the best opinions on the subject. Of the same type is the following statement: " . . . sweat is a toxic waste and is produced during fatigue. The poisons which it eliminates in 24 hours would be sufficient to endanger an adult subject. Poisoning sometimes takes place in a hot, humid atmosphere if the sweat has not been able to leave the body." This erroneous view is frequently encountered among people in industry. The statements that the blood of obese subjects is less rich in red corpuscles; that senile decay affects tall people most; that one of the effects of an electrified environment, as after a violent thunder-storm, is anemia; that the application of a moderate current appears to increase the power of muscles for several days; that "chloride of sodium intervenes in the metabolism of the body to protect the proteids," should not be allowed to pass without question. Reference is made to creatinin in connection with muscular activity, but evidently creatin is referred to.

The translation is not altogether good, and as a result unconventional expressions are occasionally used, and the author's meaning is sometimes obscure. As an example of the former, we find in the index a reference to "renal force," with a test for renal force illustrated, the test being a measure of the strength of the lumbar muscles by means of the dynamometer. As an instance of obscure meaning, the following sentence, which occurs in the discussion of nerves, may be cited: "They emanate from determined centers, these centers being cellular, but the 'nervous cell' emits a very long prolongation to the centrifugal function, the cylindric axis, and short appendices, 'the dendrites,' which connect it with the neighboring cells" (p. 99). Moreover, through some mistake of labeling or shading the drawing of the knee joint, an entirely erroneous impression of this structure is given (p. 103).

The author makes several references to differences associated with sex, but does not undertake a general discussion of these differences as bearing upon fitness for various kinds of work. The female suffers in the conventional manner through comparison but it seems a bit unfair to her to draw attention to slight differences in the water content and density of her nervous matter. She is found to possess less muscular strength, and this is more important. In view of more recent results of Martin, however, and the same criticism applies to comparisons of the strength of different races, the effect of occupation probably has not been duly taken into account.

The real contribution of Amar is in pointing out the applications of physiological methods to the study of labor, the results obtained, and those to be expected. His own work has consisted of investigations of pressure and speed of movements by means of Marey tambours and recording devices, following the lead of Imbert in this technic, and of correlating these results with observations upon the oxygen consumption, respiratory rhythm and heart beat. By means of this technic he has determined the work accomplished in relation to the energy expended in several kinds of labor, at various time rates. Interesting and valuable results are given.

Amar's chief incentive is apparently found in the shortcomings of the methods of Taylor and his followers through their failure to take into account the physiological principles concerned in human work. The same criticism has been frequently made, and indeed with justice. Industrial engineers have frequently stated speeds, loads and percentage of time in functional activity in relation to lengths of rest, without taking into account the physiological factors already known, and without making physiological research where such knowledge is inadequate. While Amar must surely convince even the practical engineer of the richness of

this field of investigation he demonstrates, perhaps more than he realizes, its present shortcomings. He is least of all to be criticized in this respect since he is actively working in this field. In making this criticism it is not my purpose to defend any continued neglect upon the part of industrial engineers to ignore physiological facts and methods in their studies, but rather to stimulate greater effort on the part of physiologists.

The two salient deficiencies, in so far as scientific management is concerned, are briefly: first, inadequate methods of determining and stating the work of the human machine; and, secondly, inadequate means of determining the effects of work upon the human machine, *i. e.*, fatigue. In the determination of work, Amar employs the customary methods used in the past. For example, a man uses both hands in filing and makes both vertical and horizontal pressure upon the file. The pressure in both directions is determined in kilograms. He moves the file a certain distance in the horizontal plane. The work which he accomplishes is determined by multiplying the horizontal pressure by the distance through which the file is moved. The downward pressure is disregarded. From a certain standpoint this may be of value — possibly, in comparing the efficiency of the human machine with other types of machines—but from the standpoint of determining quantitatively the physiological activity involved in the work as a basis of reckoning daily functional activity, it is inadequate. Total muscular activity, however, may be inferred from studies on oxygen consumption. This was done in the case of filing. It must be recognized, however, that the oxygen consumption gives no indication of the demands made upon particular muscle groups and, furthermore, that it does not indicate the demands made upon the special senses and nervous system. Our technic must, therefore, be extended to include measurements of the physiological activity of particular muscle groups and other structures concerned in work, if we are to obtain measurements indicative of the demands made upon the human machine. In connection with muscular activity it has long seemed to me that more fruitful results would be obtained by expressing this in terms of tension multiplied by time rather than of weight times distance.

In the matter of determining the effect of work upon the human organism, Amar offers little assistance to the engineer. In the examples given, he recognizes fatigue produced in the work, by irregularities in respiration, pain in a muscle group, unusually high performance in terms of kilogrammeters, and by oxygen consumption, and as we know these are not reliable criteria of fatigue. His contribution to the energy exchanges in the work of an apprentice as compared with a skilled worker is an additional plea for a detailed study of movements in occupation and standardization of the most efficient movements, which, it should be noted, may not be those of the shortest paths or necessarily those requiring the lowest oxygen consumption. The method suggested, which involves a study of the movements of the most efficient workers, is likely to prevent falling into such errors.

Amar indicates the advantages to be gained through proper selection of workmen but does not discuss this aspect of the subject. His classification of men into four types — the digestive, the muscular, the respiratory, and the nervous types, each suited especially to certain types of activity — seems far-fetched; also the statement that subjects with a stronger will have more endurance hardly admits of practical application.

Under external environment there is a brief discussion of atmospheric pressure, the effects of gases and vapors, etc. In connection with high altitudes the work of English investigators is not mentioned, and in connection with caisson sickness the advantage of gradual decompression of the air pressure is not referred to. Moreover, the work referred to in connection with the occurrence of diabetes following exposure to aluminum fumes should be questioned.

Amar is a pioneer and his excellent book should stimulate both the practical man in industry and the laboratory worker to a fuller realization of the fruits which may be reaped through endeavor in this field. — *A. H. Ryan.*

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## DUST IN PRINTERS' WORKROOMS*


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DISCUSSION having arisen in the press as to the possible relationship between tuberculosis in printers and inhalation of silica dust, I was instructed to investigate the quantity and nature of the dust in the air of workrooms in which printing processes are carried on. Some silica is found in "printer's list," a black fluffy substance which collects in compositors' cases, and its existence there has been attributed to:

1. Sand used in casting and moulding iron "chases" (the metal frames into which the type is locked). When these rust, the sand is loosened and on releasing the type, silica and oxide of iron are shaken out.

2. Silica shaken off the chases by vibration in machines.

3. The "dross" which arises from the "list" when used type is melted down. This dross is skimmed off and often stored in open chests in workrooms for months until sold.

It was suggested that the silica was carried from the compositors' cases into the air by floating vegetable fibres produced by the paper. The paper fibre was clogged into the type in the machines: when the type was released, the fibre was distributed with the silica into the cases, then thrown out into the air, and inhaled while the compositor was picking out the type he wanted.

It appeared therefore that to test these theories information on the following points would be useful: (1) *quantity of dust* in the air of printers' composing and machine rooms, and particularly as to whether the amount was in excess of that found in the air of ordinary rooms; and (2) *nature and size of dust particles*.

Determinations of the dust were made both in old-fashioned works, where conditions of air space and ventilation were usually indifferent, and in up-to-date works, under the best conditions obtainable. Altogether eight works were visited, four "good," and four "indifferent." In every case the air was drawn in at the breathing level of the workers, either in the centre of the room, or in the most crowded part.

These determinations were made by a special apparatus designed by Mr. G. E. Duckering (1). Briefly, the method consists in drawing a measured volume of the air of the workroom through a weighed filter-paper and weighing the dust col-

* Reprinted from the Annual Report of the Chief Inspector of Factories for 1920 by permission of the Controller of His Majesty's Stationery Office.

lected on the paper. From these results a figure representing the dust content of the air, known as the "dust figure," is calculated, and can be used for purposes of comparison. The dust figure is the number of milligrams of dust in 10 cubic metres of air, this being a convenient standard to adopt.

The dust collected on the filter was submitted to microscopical examination (with polarised light) with a view to determining the size and character of the constituent particles. The results of these determinations are given in Table 1. The dust figures may be compared with those in Table 2, which were obtained (1) in the open air; (2) in a laboratory.

In view of the different suggestions as to the sources of the silica, samples of dust were collected from (*a*) fluff and dust from compositors' trays and cases; (*b*) dross from melting pots in casting rooms; and (*c*) paper fibre from machine rooms. During the investigation another possible source of dust was evident, namely, the French chalk used in the moulding process; a sample of this was also taken. These samples were analysed at the government laboratory, and the results of the analysis appear in Table 3. They can be compared with an analysis of a "domestic" dust.

## Conditions in Printing Works

*Composing Rooms.* — In general, these rooms are not particularly well ventilated. Although in most cases plenty of windows (to open) are provided, they are usually found to be closed. The workers seem to prefer a warm atmosphere and object to windows being open. In some rooms, especially those used for newspaper work, there is much traffic, and in such cases the dust figure is higher than in rooms where traffic is restricted.

The dust in the trays is a woolly, felted, fluffy substance; but if the type is removed there is also found a fair quantity of fine black dust underneath the fluff. It is only to be expected that the trays, which are divided into small compartments, and only occasionally cleaned, will accumulate dust. When not in use the trays are stored away in a sort of cabinet, into which they fit like drawers. When an old case is taken into use after being disused for some length of time, an attempt is usually made to clear the dust from the small compartments. The old method of doing this, still used in many works, is to take the tray into the open air and blow the dust away with hand bellows. The more modern firms have installed dust extractors for this purpose. These are of two kinds:

1. A closed box with a fan and duct, known as the "Clements' Case Dust Extractor." The tray is placed inside the box, and the motor started. The action is threefold; the tray is agitated so as to stir up the type, the dust is blown up into the air inside the box, and drawn away by the fan through the duct into a special compartment, from which it can be cleared. The time taken to clear a tray by this method is about thirty seconds, as against fifteen to twenty minutes by the hand bellows, besides which there is no chance of the worker breathing the dust. Each compositor usually clears his own trays, as he requires them.

2. A vacuum cleaner, similar to those used for domestic purposes. A special worker is employed to go round the composing room, and keep all trays clean. Its disadvantages, as compared with the Clements' Extractor, are that there is no device for shaking up the type and so removing the dust underneath, and that light, thin pieces of type are liable to be lifted up with the dust by the suction, and carried inside the cleaner.

*Machine Rooms.* — Conditions in these rooms vary within very wide limits. Some are large and well ventilated, on the ground

floor, with good natural or mechanical ventilation. In many cases, however, the machine rooms are in the basement with artificial light constantly in use. They often appear to be overcrowded with machinery, their free ventilation being thereby restricted.

A certain amount of paper dust is usually found on the machines, the quantity varying with the kind of paper used. The principal varieties of paper met with are as follows, in the order of their dustiness:

1. *Antique wove.* — This is the dustiest paper on the market. It is used almost entirely for printing high-class novels.

2. *Antique.* — Used for cheap magazine work.

3. *News.* — Used for cheap newspapers, weekly periodicals, etc.

4. *Thin antique.* — Used for books.

5. *Smooth or calendered antique.* — Used for high-class newspapers, books, etc., and for the *outside* of weeklies and cheap magazines. A fairly smooth paper giving only a little dust.

6. *Calendered.* — Good smooth surface, giving very little dust.

7. *Super-calendered.* — Gives practically no dust.

In machine work where a dusty paper is used, the type has to be wiped frequently, as a bad impression is made in printing if the dust collects. The "clogging" of the type by dust and ink is therefore kept down to very small limits, to avoid spoiling the work. Moreover, after type is finished with and while it is still in the frame, or chase, it is usually washed with strong caustic potash solution, to remove the ink and paper fibre, before being broken up.

*Moulding Rooms.* — The chief characteristic of these rooms is the high temperature from the steam presses in use. The only possible source of dust is the French chalk used for dusting forms before and after moulding. Most firms use very little French chalk; in one case where a fair amount was used a suction fan was provided to assist in keeping the room clear of dust.

*Casting Shops.* — The processes carried on in these shops are:

1. Melting down of type (old and new). This is done in large pots, provided with hoods and ducts to carry off the fumes. The dross rises to the surface and is skimmed off. It is generally left until the next day to cool, when it is either placed in sacks or in a special closed metal bin, kept outside the workroom. It is disposed of to lead smelters (for recovery of the metal) and carted away weekly. Table 3 shows that dross contains no silica.

2. Pouring of molten type into moulds. This process gives rise to no dust.

3. Various trimming processes, *e.g.*, "routing," "shaving," etc. None of these is a dusty operation.

*Linotype and Monotype Machine Rooms.* The machines give rise to little dust; the fumes given off by the melting pots are in most cases efficiently removed by exhaust ventilation.

## Consideration of Results

In Table 1 the results have been arranged so that the amounts of dust in the air for the various processes are grouped together.

*Composing.* — Table 1 seems to show that the following factors have a determining influence on the size of the dust figure:

1. Size of room, in relation to the number of workers, *i.e.*, amount of cubic space for each worker.

2. Amount of traffic in room.

3. Amount of ventilation, *i.e.*, rate of change of air in the room.

Number 100 has the highest figure (24.4) for all composing rooms, the room being rather crowded, with much traffic. Number 107 is next, with a figure of 19.5;

TABLE 1.—RESULTS OF DETERMINATIONS OF DUST IN THE AIR OF PRINTERS' WORKROOMS

| Lab. No. | Firm No. | Process | Where Taken at Breathing Level | Approximate No. of Cu. Ft. per Person | Dust Figure (Mg. Dust per 10 Cu. M. of Air) | Results of Microscopical Examination | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Silica | | Nature | Remainder | | |
| | | | | | | Size of Particles | Proportion of Total Dust | | Size of Particles | Proportion of Total Dust | |
| | | | | | | *mm.* | | | *mm.* | | |
| 99 | 1 | composing | centre of room | 1,600 | 14.6 | 0.004–0.04 | small | Vegetable fibre and carbonaceous matter | | small | Large room, few workers. Air very still, no traffic. All windows closed. |
| 100 | 2 | " | " " " | 1,000 | 24.4 | 0.004–0.04 | " | Same as No. 99; also a little flaky mineral substance | .... | " | Rather crowded room, much traffic. |
| 105 | 4 | " | " " " | 1,200 | 14.6 | 0.004–0.04 | very little | Same as No. 99 | . | nearly all | Large room, well ventilated. Fair amount of traffic. |
| 107 | 5 | " | " " " | 800 | 19.5 | 0.004–0.04 | " " | " " " " | .... | " " | Windows all closed. Air oppressive. Several platen machines in room. |
| 110 | 6 | " | " " " | 800 | 7.4 | .... | . | " " " " | 0.004 | all | Well-ventilated room, all windows open. Little traffic. |
| 111 | 7 | " | " " " | 1,200 | 7.3 | .... | | " " " " | 0.004 | " | Large room, few workers. No traffic. |
| 113 | 8 | " | " " " | 5,500 | 7.3 | .... | .... | Same as No. 100 | up to 0.07 | " | Large lofty room; a model composing room. Good ventilation. Fair amount of traffic. |
| 115 | 9 | " | " " " | 800 | 18.2 | .... | .... | Same as No. 99 | .... | " | Large room, well ventilated, but rather crowded, and much traffic. |
| 103 | 2 | machine work (rotary machines) | " " " | 1,000 | 11.6 | . | very little | Same as No. 100 | 0.04 | nearly all | Large room, but many machines. Air oppressive. "News" paper being used. |
| 106 | 4 | machine work (flat bed machines) | " " " | 4,400 | 14.5 | | | " " " " | | " " | Good large room, well ventilated. Very dusty "antique" paper being used. |
| 108 | 5 | machine work (rotary machines) | cutter end of machine | 1,500 | 31.7 | | trace only | Same as No. 100; vegetable tissue with cell structure | up to 0.01 | " " | Low ceilinged room, much machinery. Rough "news" paper. |
| 109 | 6 | machine work (flat bed machines) | between two machines | 3,000 | 4.9 | | " " | Same as No. 99 | under 0.004 | " " | Well-ventilated room, with permanent ventilators in roof. Smooth calendered paper. |
| 112 | 7 | machine work (platens) | centre of room | 450 | 18.3 | | " " | " " " " | " " | " " | Small crowded room in basement. Ventilation poor. Calendered paper. |
| 114 | 8 | machine work (flat bed machines) | " " " | 3,000 | 1.0 | ... | " " | " " " " | " " | " " | Large, lofty, well-ventilated room. Calendered paper. |
| 106 | 9 | machine work (rotary machines) | " " " | 4,200 | 9.8 | .... | " " | " " " " | " " | " " | Well-ventilated room. Calendered paper. |
| 101 | 2 | Moulding...... | centre of room (near press) | 1,800 | 24.4 | .... | very little | Same as No. 100 | 0.01–0.04 | " " | Much French chalk used. Mechanical ventilation by fan. |
| 102 | 2 | Casting........ | centre of room (near press) | 2,200 | 24.4 | .... | " " | " " " " | 0.01–0.04 | " " | Low, dark room, much machinery. Ventilation fair. |

the ventilation was poor, and the presence of platen machines raised the dust content of the air. Number 115 (18.2) was a well-ventilated room, but was somewhat crowded, and much traffic was going on. Numbers 99 and 105 have the same figure (14.6); in one case all windows were closed and there was no traffic, and in the other case there was good ventilation and much traffic. The lowest figure of all is 7.3, obtained in two cases in which all the factors contributed to a low dust content. The average figure for the eight samples is 14.1.

*Machine Work.* — Here, besides the air space and ventilation, the kind of paper in use is seen to influence the figure. Number 108 is highest (31.7), the ventilation being indifferent and the paper dusty. Number 112 was taken in the least satisfactory room encountered, but the paper used was of a smooth, calendered type, so that the dust figure (18.3) is moderate. Number 114 was taken under what might be termed ideal conditions — a large, lofty, well-ventilated machine room, and a smooth calendered paper. The dust figure (1.0) is practically negligible. The average figure for the seven samples is 13.1

*Moulding and Casting.* — The dust figure in these rooms (24.4) is somewhat in excess of the average figure for machine and composing rooms. This is explained, in the case of the moulding room, by the quantity of French chalk in use, and, in the case of the casting room, by the relatively large amount of traffic at the time of sampling.

*Results of Microscopical Examination* (*Table 1*). — This examination was carried out by Dr. H. H. C. Thomas, D.Sc., at the Geological Survey and Museum, Jermyn Street. The results show that, in all printing processes, the quantity of silica in the dust of the air is extremely small — in some cases so small as to escape detection. It appears, therefore, that the workers breathe very little, if any, silica. The dust consists for the most part of vegetable fibre and carbonaceous matter. In one case (No. 108), in which a rough "news" paper was being used, the vegetable fibre is described as having "good vegetable tissue with cell structure. The tissue and structure indicate straw or grass particles." Possibly some variety of straw or grass had been used in the manufacturing of the paper. In all cases the vegetable fibre is described as being "not such as would be yielded by filter paper," *i. e.*, by the material on which the samples were collected.

TABLE 2. — RESULTS OF DETERMINATIONS OF DUST IN AIR AND IN ROOMS WHERE ATMOSPHERE WAS NOT DUSTY

| Point at Which Determinations Were Made | Milligrams of Dust in 10 Cubic Metres of Air |
|---|---|
| Centre of garden, Edgbaston, after three fine days | 2.1 |
| Same point after four days of fine weather | 2.8 |
| Same point after thirty-six hours of heavy rain | 0.7 |
| Centre of study, Edgbaston | 7.7 |
| Open air outside laboratory, Stoke, centre of a manufacturing district | 9.4 |
| Centre of laboratory, Stoke | 18.5 |
| Side of laboratory, Stoke | 10.8 |
| Side of laboratory, Oxford | 12.6 |

Table 2 shows the results of determinations of dust in the open air and in rooms where the atmosphere was not dusty.

The dust figure of the atmosphere appears from these determinations to vary from 0.7, under ideal conditions (open air after heavy rain), to 18.5, this being the figure in a laboratory in a manufacturing town. Out of eight samples taken in composing rooms, in only two cases is this latter figure exceeded, and out of seven samples taken in machine rooms, in only one case, while the average figure for both these classes of work (14.1 and 13.1 respectively) is well below. Moreover, the figure 18.5 represents the dust in the air of an empty room with no traffic of any sort. A com-

parison of Tables 1 and 2, therefore, shows that printers' workrooms are by no means dusty.

Table 3 shows the results of analyses made at the government laboratory of nine samples of dust taken from printing works. This table gives the analysis of the sources from which it has been alleged that silica may get into the dust of the air. The highest percentage of "free" silica found is 6.31, the average being 3.35. Silica dust is comparatively heavy, so that the percentage of silica actually breathed by the worker is probably much lower than this. The remainder of the silica in the samples, included from the heading of "total silica," is present in the combined form, as silicates, in which form it is considered to be innocuous (2).

The following is an analysis of a sample of "dross": antimony, 16.49; lead, 68.23; tin, 12.50; copper, 0.12; iron, 0.09; zinc, 0.26; arsenic, 0.09; oxygen, 2.22; total, 100.00. It shows that dross, which is one of the alleged sources of silica, is entirely of metallic constitution. When type is melted down, the oil and other organic matter rise to the surface and are vaporised, the vapours passing into the hood above the casting pot. A certain amount of the metal separates from the alloy in a granular condition and is skimmed off. These skimmings are the dross and consist entirely of metal and occasionally a little metallic oxide.

"Total silica" in dust from printing works, when compared with that of London "domestic" dust taken from the top of a wardrobe,* comes out much the lower of the two.

TABLE 3.—RESULTS OF ANALYSES OF DUST SAMPLES FROM PRINTING WORKS

| Sample No. | Firm No. | Where Taken | Organic Matter and Moisture | Lead | Other Heavy Metals | Total Silica | Other Inorganic Substances | Total | "Free" Silica (Included in Total Silica) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | Type cases, composing room..... | 66.00 | 2.80 | 3.20 | 8.95 | 19.05 | 100.0 | 4.33 |
| 2 | 1 | Inside Clements' dust extractor.. | 59.00 | 8.92 | 4.08 | 9.96 | 18.04 | 100.0 | 6.31 |
| 3 | 2 | Inside Clements' dust extractor.. | 40.00 | 23.75 | 6.25 | 8.63 | 21.37 | 100.0 | 1.32 |
| 4 | 2 | Machine room................. | 71.00 | .... | traces | 11.45 | 17.55 | 100.0 | 2.50 |
| 5 | 2 | Inside fan in moulding room..... | 47.00 | 0.51 | 0.49 | 13.23 | 38.77 | 100.0 | 3.16 |
| 6 | 5 | Type cases, composing room..... | 68.00 | 4.68 | 1.32 | 8.48 | 17.52 | 100.0 | 3.21 |
| 7 | 9 | Inside dust extractor........... | 56.00 | 4.39 | 1.61 | 13.72 | 24.28 | 100.0 | 4.24 |
| 8 | 4 | Machine room................. | 74.00 | traces | traces | 12.00 | 14.00 | 100.0 | 1.78 |

## CONCLUSIONS

1. Printing cannot be described as a "dusty" trade. The average quantity of dust in the air is no higher, and in some cases considerably less, than that in the air of many occupied rooms.

2. The dust in the air contains very little silica—in some cases a negligible quantity.

3. The dust in compositors' cases, in machine rooms, and in other dust-producing sources contains less silica than dust collected from a living room.

4. On the grounds of the presence of lead alone in the dust of the type cases, it is desirable that some apparatus, such as the Clements' Case Dust Extractor, should be used, particularly in large works, for removing the dust from the trays and cases. Such apparatus should be so constructed

* The analysis of this is given by Sir J. Crichton-Browne in the *Times* of Nov. 3, 1920, as follows: moisture, 4.4; organic matter, 52.6; silica and insoluble silicates, 21.0; iron oxide and alumina, 9.7; lime (CaO), 6.2; carbonic acid, with traces of sulphuric and phosphoric acids, 6.1; total, 100.0.

that the dust does not escape into the air during the process of removal.

The laboratory work in connection with the dust determinations was carried out by me at the South Western Polytechnic Institute, Chelsea, and the thanks of the Department are due to the authorities for the facilities given.

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# INFLUENCE OF INDUSTRIAL NOISES*

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THIS memoir — a résumé of all that was known in 1914 in regard to the influence of industrial noises — was originally written at the request of the Third International Congress on Occupational Diseases due to be held at Vienna in the later half of August, 1914, and was intended to open the debate on the subject. As the author lived in the occupied part of Belgium during the war, he had no access to new work, but nothing new appears to have been discovered, except that we have since learned of the idea that deafness following an explosion is usually temporary except when the auditory nerve is affected. It seems wise, however, to re-introduce so important a subject in order to stimulate research on the part of ear specialists. The influence of noise, which is at times deafening, has been little studied in spite of the fact that it is present in nearly all industries. The author, although not an ear specialist, feels justified in writing this résumé because it states the present position; because there is confusion among ear specialists; and because of his twenty years' experience in factory work which has enabled him to bring out the etiological factor in questions on which industrial doctors require a solution from ear specialists.

## Deafness as an Occupational Disease or Accident

Deafness as an occupational disease should be studied separately from deafness caused by traumatic lesions due to explosions, gun fire, blasting, etc., which cause immediate lesions, although the difference is perhaps somewhat subtle. Save in special cases where initial lesions are clearly recognized as immediate, it is only after repeated injuries that ear affections become obvious, and therefore it is nearly always convenient to classify the deafness of gunners and firers of mines among occupational diseases rather than among accidents. Consequently, for practical purposes we may include the affections caused by injurious action of the air during firing among ear injuries caused by noise proper.

## Outline of Previous Investigations

Classic writers on occupational diseases are generally reticent on the subject of disorders caused by noise in industry. Layet (1) points out that the deafness of coppersmiths was known of old and that sheet iron workers, coppersmiths, blacksmiths, and coopers are nearly always hard of hearing and become more so the longer they remain at their trade — a perversion of hearing shown by increased perception of high notes or loss of perception of low notes. Layet observed an old foreman who appeared to hear only in the midst of the greatest noise, while at other times he complained of continual buzzing in his ears, so that he was an example not only of the phenomenon of Willis but of other ear trouble. This phenomenon of Willis (hearing better when a certain sound is present than under ordinary conditions) is frequent in noisy industries, where another phenomenon is also observed which must not be confounded with that of Willis — namely, the power of certain workers to converse together in a nearly normal voice when a

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stranger is at the time deafened and incapable of making himself heard without raising his voice. In factories for removal of coarse hair from furs by machinery or in works where hatters furriers' processes are carried on amid intense noise, I have often observed the workers laughing and talking together when I could not hear the sound of their voices. Is there a special adaptation of the worker's voice or a particular accommodation of the organism of the ear, or both? Be it as it may, this phenomenon is not necessarily accompanied by a diminution of hearing in a quiet atmosphere.

According to Roosa, workers in a noisy atmosphere get a true nerve lesion; they hear less well and do not recover their acuity of hearing except by staying off work for some time, and eventually the auditory trouble becomes permanent. According to Dr. Moure of Bordeaux, the more the noise produced in a small, closed and resounding space, the more rapid is the damage to the auditory nerve; that is why he considers as the most exposed young persons who are employed in coppersmiths' workshops to assist riveters in the interior of boilers in holding rivets in place during hammering. It is necessary to class with this group young persons who enter the boilers for the purpose of removing the deposit (boiler cleaners). My personal experience confirms the fact that these workers at times leave this noisy atmosphere absolutely dazed, deaf, and in a state of vertigo which lasts for several minutes. These facts may be compared with those observed in ironclads after a sea battle and in this connection De Merrys reports that on the Cesarewitsch, twenty-four hours after the engagement, many men complained of headache, loss of memory, and deafness.

Other influences, however, than that of a resounding medium can be cited to explain auditory lesions of workers in an enclosed space. Della Vedova of Milan, at the Seventh Italian Congress of Laryngology and Rhinology, insisted on good ventilation in enclosed spaces and pointed out among the causes harmful to hearing, dust, irritating gases, high temperature, dampness, and variations of atmospheric pressure, and cited as a proof of the injurious influence of a confined space the fact that among soldiers inflammatory conditions of the ear are less frequent during manoeuvres than during life in barracks.

As far back as 1877, the replacement on railways of shrill toned whistles by those of a deeper note or by other signals, such as bells, was suggested. Hedinger, in 1882, tested the hearing of 1,100 railway employees and found only 48 per cent. of hardness of hearing among engine drivers and stokers as against 95 per cent. among the other employees. He concludes that intemperate habits are much more the cause of catarrhal affections of the ear than is the engine whistle. Guterbock states that hardness of hearing among engine drivers increases in proportion to the length of service, as the following table shows:

| *Years of Service* | *Percentage of Defective Hearers* |
|---|---|
| Less than 5 | 5.8 |
| From 5 to 9 | 7.3 |
| From 10 to 14 | 8.0 |
| From 15 to 19 | 31.8 |
| More than 20 | 52.1 |

Dr. G. Boval likewise states that the deafness of engine drivers and stokers increases with age and years of service from 11.7 to 62 per cent. according to age, and from 18 to 75 per cent. according to years of service. Barr makes similar observations on 100 persons; after seventeen and one-half years' service none heard a watch normally, fifty could not hear the low voice, thirty-three perceived it with both ears, and eight with only one ear.

It is surprising that observations in textile industries are rare. Röpke (2) refers to the examination of twenty spinstresses,

fourteen of whom were hard of hearing, and of fourteen weavers, none of whom heard normally. Dr. E. Coosemans, at the Sixth International Congress of Otology held in London in 1899, read a paper on hearing among "beetlers," who, after ten or twelve hours of daily labor, exhibit more or less marked deafness, which diminishes after a few hours, and which becomes normal after a Sunday's rest.

Another injurious occupation is that of telephone workers. Capart (3), reporting upon the telephone industry, stated that: (1) Occupational use of the telephone is a cause of fatigue to the ear, which may be aggravated too far by certain circumstances, such as production of induction currents, sudden opening and shutting of the circuit, etc.; and (2) fatigue and overwork of telephonists are at times the cause of various neuroses, neurasthenia, hysteria, etc. However, others, as Dr. N. R. Blegvad (4) are less pessimistic and do not think that telephone work hastens, or makes active, pre-existing ear affections. Generally the power of perception of high sounds is little altered. Of 354 telephone employees examined with regard to the lowest sound perceptible to the normal ear (sixteen vibrations), seventy-five could not perceive it on one or both sides. Blegvad admits that among certain individuals employment can cause earache, buzzing, vertigo, or Ménière's syndrome. Recently Dr. Trétrôp of Antwerp (5) reported two ear accidents, one to a telephone girl, and the other to a merchant speaking on the telephone, which he attributed to the too sudden breaking of a current of which the voltage had lately been increased to 20 volts.

Attention was first drawn to the action of reports and explosions on the ear when the use of gunpowder was introduced. Ambroise Paré taught us that heavy artillery could cause ear lesions and cerebral concussion. Layet (6) mentions the investigations of Percy who pointed out hemorrhages following a ruptured tympanum, with persistent severe headache, more or less pronounced disturbances of hearing, and refractory otitis following on the non-cicatrization of the rupture. He also recalls Barthelemy's remarks on a momentary hardness of hearing with hissings, buzzings, and "still noises," (proof of nerve trouble) met with among gunners after firing. These observations, however, were made before war was brought to a fine art, and require re-investigation to prove whether or not they are true.

Delsaux has analyzed all the work on the noise of explosions and firing, and recalls the work of R. Müller who examined fifty-one gunners, noting the extent of their hearing before firing and three days after. Six were excluded because their ears were plugged with wax; of the remainder examined before firing, thirty-four were normal and all the others had symptoms of actual disease or signs of old cicatrices. After firing, fifty-two ears remained *in statu quo* and all the others showed tympanic congestion. There were seven cases of hemorrhage of the tympanum but none of rupture of the membrane. The duration of perception of the tuning fork by bone conduction was shortened. On the subject of air conduction, the author is reticent and calls for further investigation. It is the experience of Cheatle, in England, that naval officers are more affected than their men and that the very high tone of guns of small calibre and of machine guns is more injurious than that of big guns. In addition, autopsies as well as experiments on animals corroborate the fact that occupational noises are capable of seriously injuring the organs of hearing.

## Elementary Knowledge

In reading works on the subject of the influence of industrial noises, one is constantly meeting vague expressions, such as

"muffled sounds," "light sound," "great noise," etc., which it is necessary to define uniformly.

It is generally admitted that all sounds and noises which the ear receives can be referred to musical sounds. Noise proper is composed of a rapid and irregular succession of different auditory sensations. Sound, on the contrary, is uniform, calm, and without variations in its component parts. It possesses three principal qualities which are peculiar to it: intensity, resulting from amplitude of vibration and diminishing by distance in proportion to the square of the distance, from the fact of the diminution of the amplitude of vibrations transmitted; height, which increases with the number of vibrations; and tone, which depends on the harmonies, "superior or inferior," of the fundamental sound. Certain authorities add to intensity, height, and tone the idea of duration. To these intrinsic qualities of sound must be added an extrinsic quality described thus by Helmholtz: "In the main, in sounds of equal strength the sensibility of the ear changes with the height of the sound." Zwaardemaker (7) formulates the following conclusions as to this variable sensibility of the ear for different sounds:

1. The maximum sensibility of the human ear responds to 3,072 double vibrations (g4 of the German notation, sol 6 of the French notation).
2. The zone of very distinct sensibility extends from 256 double vibrations to 6,144 double vibrations.
3. Outside this zone to the limits of the scale, sensibility diminishes considerably.

There are three principal theories of the way in which sound is perceived:

1. *Helmholtz's Theory.* — The organ of Corti vibrates in concert. The elements of the internal ear are attuned to different heights of sound; low sounds are perceived by the part furthest from the base of the cochlea, while sharp sounds are perceived nearest this base.

2. *Hydrodynamic Theory of Bonnier* (8). — The liquid of the cochlea moves in bulk and rubs the sensory epithelium. Bonnier compares the organs of the ear not to resonators, but to registers.

3. *Pressure Theory of Marage.* — The perception of sounds is due to differences in the pressure of the endolymph, with no definite auditory localization.

Musical sounds proper are met at times in industry, as in hammering deep-toned metals, but these more or less pure sounds are rarely isolated. More usually noise proper is heard, but that also has its intensity, height, and tone. It is comparatively easy to determine experimentally the relative intensity of an industrial noise when it is regular and more or less continuous and can be compared to another noise, a short distance away, of constant intensity and sufficient to rise above it. The measure of the displacement required would give the relative intensity. Exact estimation of the height of noises is much more difficult, and we must, for the most part, rely on a few observers for this information. Although a well-trained ear learns by practice to grade the tone of noises by comparison with a known height of tone, it would be more satisfactory if the ear specialist would furnish a precise method of determining as nearly as possible the notation of different noises. Tone, on the other hand, can be described with sufficient precision for practical purposes. It characterizes the source of noise; it enables one to distinguish various machines in action, without seeing them; and, in combination with height, it gives to certain noises that disagreeable character which is peculiar to them — *e.g.*, the rasping noise in the finishing off of white stones, or the grating of saws or files. When it has this unpleasant character, tone is important in observations, as it inevitably has an ill effect on persons of nervous temperament. It is also necessary to pay attention to the

rhythm, and the continuity, regularity, or irregularity of a noise essentially uniform are also factors to be dealt with. The unexpectedness of certain short, loud noises bursting forth at rather long intervals has a disagreeable effect on the nervous system. Finally, it is necessary to have comparative information on the subject of intensity of vibration communicated to the ground and to the body of a worker by the vibrating of noisy machines. This information is not difficult to obtain.

## Noisy Trades

It would be wrong to imagine that all the employees in a brass foundry, in large iron works, or in shipbuilding yards are equally exposed to noise in their work. We must have a reasonable classification which will serve to show that it is necessary in each group to take into account accessory circumstances. Take, as an example, flax spinning which must be carefully distinguished from weaving of linen, just as it must not be confounded with "steeping" and "stripping" or "scutching," — the operations which precede it.

In a linen factory one meets all the scale of noises: there are quiet processes, as winding, or reeling, and heckling; less quiet processes, as drying and packing; noisy ones, as combing by machinery, carding; and, finally, very noisy ones, as in the preparing rooms and spinning rooms where the noise is so great that orders have to be given by means of a shrill whistle. Hence, one sees the inaccuracy of medical observation which is limited to describing the examinees as workers in the linen industry. Carding, preparation, etc., irritate the nasopharynx by dust, and spinning gives rise to similar trouble because of the humidity and heat which may cause "chills." Combing by machinery exposes the young worker to dust and muscular strain.

In many factories the noise is great in certain places and not in others, as in metal stamping, especially in making metal boxes. Very often in these works there are quiet corners, also the noise of one stamping machine varies from another, and curiously enough it is not always the stamper who is most exposed to the noise of his own machine. Certain other occupations are quite unknown to aurists. How many of them suspect that in the preparation of little rubber objects such as nipples for feeding bottles and toy balloons, there exists at times noise comparable to that of the loudest hammering. These examples are sufficient to prove the necessity for medical inspectors of factories to draw up a list of noisy industries which would serve as far as possible as a basis of comparison, and to point out all the other peculiarities which may influence health. The ear specialist ought to be in possession of all the facts before he pronounces on the etiology of a lesion, and he should take into account all the causes other than noise which could explain in part or in whole the malady observed.

In addition to information in regard to noise, the aurist should know in detail the peculiar health conditions of certain trades. Lesions of the middle ear or nasopharynx are in themselves a menace to the integrity of hearing. Noise being equal, trades which specially expose a worker to these lesions are more harmful to hearing than others; hence, the necessity of paying attention to different accessory risks, such as mercury, carbon bisulphide, and especially lead, which is a poison to the internal ear. Irritant vapors, or acid fumes, and toxic gases, such as carbon monoxide, in the form of slow chronic poisoning attack hearing as well as memory. In the same way, it is necessary to note the influence of heat, humidity, and dusts. Moreover, the influence of fatigue, muscular and intellectual, must be remembered. Fatigue in

itself lessens auditory acuity even when not excessive. For example, examination of twenty-four bicyclists who had ridden 50 kilometers showed that air perception was diminished, especially for sharp sounds (9). After a few hours' rest hearing had already improved. Finally, it must be remembered that ear lesions are often accompanied by loss of sense of space (vertigo, Ménière's syndrome), and in this connection I wish to note the occupational risk on ladders, scaffolding, and work in particularly dangerous places.

## Nature of Lesions

According to Layet, most authors think that noise is a determining factor in causing a true lesion of the auditory nerve. At the autopsy of an old coppersmith afflicted during life with occupational deafness, Habermann found degeneration of the organ of Corti and other nerve elements at the base of the cochlea. Similar lesions were found by the same author at the autopsies of several other subjects afflicted with deafness which was considered to be due to occupation. Moure, of Bordeaux, is of the opinion that, when the occupational disease is established and, in spite of rest, hearing does not return, it is a question of deep-seated trouble — a labyrinthine affection, of which the diagnosis is certain and proved by acoustic tests, before the absence of lesions of other parts, such as tympanum, tubes, and ossicles, is objectively proved.

Wittmaack has made considerable progress in the question of lesions caused by noise. He has demonstrated that animals, subjected under certain conditions to the action of a noise of varied duration, with or without rest, show profound lesions. On microscopic examination the middle ear appeared intact, as did also the vestibule, while obvious changes were seen in the internal ear in the region of the cochlea. Wittmaack's work has been controlled by Professor Siebenmann and his pupil, Dr. Yoshii, with varied intensities of sound. These authors constantly found visible and characteristic anatomic lesions of the organ of hearing. These lesions, varying with the sound used, took effect on the organ of Corti, and the nerve fibers and cell ganglia. It is useful also to recall that, with a pure sound, always the same, Wittmaack found a lesion of the cochlea peculiar to itself in each case.

H. Marx, of Heidelberg, experimenting on guinea-pigs under conditions similar to his predecessors, obtained similar results, at least in the main points. The degeneration of the organ of Corti, however, was found to be situated a little further from the base of the cochlea than that found by Wittmaack. Von Eicken, studying the action of deep sounds produced by organ pipes, states that, when the middle ear is normal, certain deep sounds cause alterations of the cochlea at the level of the second turn of the spiral. Other deep sounds, on the other hand, appear harmless. Delsaux summarizes the conclusions to be drawn from the patient, and extremely careful, researches of Haenli. Violent excitation of hearing, or reports, attack at first the terminal organ which they destroy in a certain way and it is only later that the neurones atrophy. Later still, there appear alterations in the membrane of Reissner.

A good synopsis of the results of Wittmaack's, Siebenmann's and Yoshii's experiments is found in the very instructive work of E. J. Moure and P. Cauzard on functional examination of the labyrinth (10). The authors of this work are inclined to consider the experimental results as proved definitely, and allow the following assertions of Wittmaack: (1) the integrity of the vestibule in lesions due to noise; (2) the destruction or alteration of the same section of the cochlea by sounds

of the same instrument (whistle). In a personal communication to these authors, Siebenmann expresses himself thus: "It follows (from the experiments of Wittmaack and his school) that a pure sound only affects a single point of the cochlea and that the lower the sound is, the higher the point is found in the cochlear region."

From the analysis of twenty principal clinical works on the results of reports and explosions, Delsaux concludes that the disorders of hearing or the lesions of the ear arising from these causes may be classified as: (1) lesions of the tympanum; (2) lesions of the drum; (3) disturbance of the labyrinth; (4) progressive deafness; and (5) diverse nervous disorders. He states that all experiments tend to show that, apart from ruptures of the tympanum and lesions of the drum, and, in rare cases, lesions of the ossicles, injury to the ear by detonations gives rise in the internal ear to temporary or progressive or definitive lesions, situated mostly in the tympanic slope of the cochlea and rarely and temporarily in the vestibular slope or in the static apparatus of the internal ear. Finally, it is well to keep in mind the views suggested to Layet by Dr. Moure, namely, that when the organs are intact the principal industrial noises act on the labyrinth, while reports and explosions may also act directly on the organs of the middle ear.

### Transmission of Noise by Air and by Solid Substances

Must one blame noise transmitted at the same time by air and by solid bodies? Must one, on the other hand, consider air vibration alone as practically harmless and blame chiefly vibrations and tremors which are communicated to the bony skeleton? This is a necessary point in prophylaxis. It is a problem, the solution of which, if it can be obtained, will revolutionize the methods of protecting the worker and the legal measures formulated by different governments.

The accidental results of great explosions or a sudden change of pressure among workers in an atmosphere of compressed air must be excluded. These are cases of "superior force," the effects of which cannot be used as a proof for or against the theory as to the cause of it. Would it not be wise also to exclude the results of reports and explosions knowingly caused? Truly, the deafness of gunners is an occupational one, but the conditions producing it are not met with in industry, except quite exceptionally among those employed in shooting galleries or attached to depots for testing firearms. In firing a mine, it is obviously wise that workers who start the fuse should be as far away as possible, and consequently lesions of the ear among them ought to be much more often in the category of occupational accidents than of occupational diseases. In addition, the violent disturbances which occur from the deflagration of explosives singularly complicate the principle of the problem. Hence, it would perhaps be wise to limit the subject to industrial noises, properly so called, which are far more frequent. In return, it would be useful to compare the influence of vibrations where the noise is dominant, with the action of vibrations when shaking is the principal cause of trouble.

There are a great number of workers on trains, trams, and vehicles of all kinds, whose whole bodies are for many hours exposed to an energetic vibratory shaking, without which, however, the noise to which these workers are exposed would still be considered as excessive. Whatever the value of these previous remarks may be, let us examine the main sources of information at our disposal.

Castex, in 1897, speaking of engine drivers and stokers, pointed out the harmful influence of vibration: "shaking acts on the labyrinth and causes sclerosis, as

seen in the occupation of hammering." This is the conclusion, aptly expressed, to which Wittmaack came in his remarkable experiments, begun in 1903, on both ears of ninety guinea-pigs. Six guinea-pigs were subjected night and day, without interruption, to the noise of an electric bell, freely suspended above their cage. The animals were killed in succession after 5, 10, 20, 30, 40 and 60 days, and no lesion was found in any part of the auditory apparatus. This negative result gave rise to the idea that ear affection caused by noise must be due to something more than the simple transmission by air. He therefore modified his experiments in such a way that the vibrations of the electric bell were communicated to a tin plate on the floor of the cage. Very different results were then obtained; rapid emaciation of the animals was observed and two died after 14 days. Controlled experiments led to the same results and although, as before, the middle ear of animals killed after various intervals appeared intact, the nerve terminals in the cochlea, especially the organ of Corti, were degenerated. Analogous experiments, in which sufficient rest was allowed to resemble the normal conditions of human industry as far as possible, furnished similar results. Wittmaack tried also the influence of other noises, especially that of a whistle, as well as air disturbance caused by firearms. As a conclusion to his researches, he admits the preponderating influence of vibrations of solid substances on lesions of the ear, due to sounds, and he calls attention to the fact that among workers most frequently afflicted with occupational deafness one finds nearly always the possible transmission of vibrations by the bony skeleton, especially among blacksmiths, in whose work they are transmitted by the arm. In noisy factories the constant vibration of the ground is frequently observed.

According to Peyser, Wittmaack's first statement is of minor importance; the second on the other hand is of capital interest. The elasticity of the soft parts and articulations of the wrist and of the arm appeared to him to be a good non-conductor while the heavy body of the worker resting on vibrating ground, and especially the bony frame, from feet to head, would be favorable conductors for the transmission of vibration. An intermediate condition would be that of boiler riveters, who support their mechanical hammers by propping their elbows against their chests. In corroboration, Peyser cites the authority of Friederick of Kiel, who thinks that the deafness of naval officers is at least partially attributable to vibrations of the ship during firing. Finally, with the object of studying the influence of conduction almost exclusively by air, Peyser examined the builders of hulks made of curved iron sheets which have to be riveted. During construction the hulk is placed on the ground, with the keel in the air, and supported on wooden blocks which rest on a mass of concrete 30 centimeters thick. The worker crawls under this metallic arch and proceeds to rivet by means of percussion hammers worked by compressed air. Of twelve workers engaged for two years at this work, none had become hard of hearing at the time the examination was made. Peyser concludes that this confirms the theory of Wittmaack on the influence of vibrations. Neither the number of observations, however, nor the length of time of service allow final conclusions to be drawn. Peyser concludes with the following statements:

1. Continual, but moderate noise, exclusively transmitted by air, has little or no action on the organ of hearing.

2. Short, but intense and shrill sounds, especially when repeated, injure the organ of hearing in a temporary or a permanent way.

3. Simultaneous conduction of noise by air and by the bony skeleton, and above all by the vibration of the ground, affects hearing finally and seriously.

Everyone does not admit the opinions of Wittmaack and Peyser. Reinking of Hamburg, at the last German Congress of Otology, made a communication tending to show the importance of the harm of air conduction. Delsaux could not agree entirely with Reinking concerning the minor importance of bone conduction and rightly put forward a statement, easy to prove, that it was not sufficient in normal conditions to stop up the nose, mouth and ears in order not to perceive any longer at a meter's distance words uttered in a high voice. One must admit in this case that sound is transmitted by way of a solid substance. On the other hand, Delsaux observed that the statements of Coosemans on "beetlers" in a linen factory contradict the conclusions of Wittmaack and Peyser. In fact, Coosemans has not found really serious lesions among workers whom he has examined and who were subjected at the same time to a muffled sound and to continual vibrations of the ground. He concludes that: (1) Every noisy trade is not necessarily harmful to hearing. (2) In order that it may be harmful, it is necessary (*a*) that the worker should be predisposed to affections of the ear, by the presence of lesions in the nose or pharynx; (*b*) that the noise should be intermittent; and (*c*) that it should be of a relatively high tone.

From the foregoing, it must be concluded that a certain amount of doubt still exists as to the extent of harmfulness of transmission of sound by air. Let us hope that future research may procure definite results on this point so important to industrial hygiene.

## Prophylaxis

*Choice of Worker.* — Only young people fitted to undergo the normal consequences without damage should be allowed to work in noisy industries. Young persons with ear affections or predisposed to them by lesions in the neighborhood of the ear should be prohibited. This conservative method must, however, be used with great prudence. Statistics show that the number of persons with deficient hearing is considerable. According to Ely, 8.5 per cent. of conscripts were refused for this reason — a percentage which represents only the worst cases. Weill reports 30 per cent. of 5,905 children, whom he examined, as hard of hearing; Moure reports 17 per cent. out of 3,588; Bezold reports 20.75 per cent. out of 3,836, with ear trouble; Lausi shows 10.8 per cent. of deaf scholars; Sexton 13 per cent.; Gelle and Von Riechardt 22 per cent.; Ostman 36 per cent.; Nager 40.3 per cent.; Röpke 23.6 per cent.; Cronenberg 44.1 per cent.; Hansberg 50 per cent.; Felix 31 per cent.; Courtade 37.5 per cent.; Malherbe and Stackler 35 per cent. If these large numbers of deaf or partially deaf children were excluded from noisy industries, factories would soon be empty, for other groups of sick or puny children would also have to be excluded, one for deficiency of vision, another for poor development, and another for some physical disability. Also the law of work is universal and the weak and infirm must work for their living; but as a defect such as an ear lesion may be an indication of a more general disease, those who are excluded from noisy industries because they are partially deaf may find that they are refused entrance to any work at all. Great discretion must therefore be used, and only those most liable to harm should be prevented from entering the most injurious industries. This tolerance, however, requires a safeguard in the form of periodic medical supervision of young persons. In the same way it will be necessary to have a methodical periodic examination of the ears of adults working in noisy industries. At first one would imagine that an essentially defective ear would be an indication that the subject

should not work in a noisy atmosphere. But if Eicken and de Hoessli are correct in their assertions that the chains of ossicles conduct sound and do not damp it, as Zimmerman thinks, in certain circumstances a state of relative deafness, while not advantageous, would at least be harmless in certain industries where there is a loud or rackety noise.

When choosing workers for a noisy industry (and in doubtful cases this should be done by an ear specialist), the doctor must keep in mind the other peculiarities of the industry. For instance, a deaf man is more exposed to accidents in the vicinity of belts, gearing, etc., because very often when a machine is going wrong an unusual sound is emitted which acts as a warning. In the same way workers with alterations in the auditory apparatus associated with vertigo and loss of sense of space should not be exposed to falls from heights, such as from scaffolding, timber works, or bridges. In the medical examination a fixed unit of measurement should be employed throughout the country, so that absurd and unfair situations may be avoided; better still, there should be international uniformity to enable us to meet hostile criticism on prophylactic measures. At present, tests of hearing lack uniformity and even precision: the whispered voice, the murmured voice, the voice of conversation and the tick of a watch are very variable quantities. Still, if judiciously employed, these simple methods seem to suffice in ordinary examinations. A definite criterion is, however, needed for determining whether or not a more complete examination by an ear specialist is desirable.

As a means of securing uniformity in ear examinations, the following methods of estimating hearing in terms of the distance at which a watch is heard by the normal ear have been proposed:

1. Let $M$ be the distance at which a watch is heard by a normal ear;

Let $d$ be the distance at which a watch is heard by the examinee;

Let $A$ be the auditory acuity of the examinee;

Therefore $A = \frac{d}{M}$;

Therefore, if $M$ is 1 meter and $d$ is 10 centimeters, $A = 0.10$ meter.

2. Let $D$ be the maximum distance at which the normal ear hears the instrument of measurement;

Let $d$ be the maximum distance for the ear examined;

Let $A$ be the auditory acuity of the examinee;

Therefore $A = \left(\frac{d}{D}\right)^2$ since the intensity of sound is in inverse proportion to the square of the distances.

Ear specialists must aid us in drawing up examinations which will be uniform as to tests, signs and terms, and must determine for us the best methods to use, and at precisely what stage hearing is sufficiently diminished (*a*) to warrant refusing a young person work after a complete ear examination; and (*b*) to require an examination by an ear specialist of workers (young persons or adults) employed in noisy industries. It will be the particular field of ear specialists to do research on "the sense of space" and "the organ of equilibrium," and on such diseases as nystagmus, while the factory doctor can limit himself to finding the degree of vertigo or incoordination by the ordinary clinical means, and can pass on to the specialists the most interesting patients.

*Individual Means of Protection.* — The means of self-protection tend to muffle sound, and plugs of cotton wool and covering pads, and especially helmets and similar apparatus, are makeshifts disliked by the workmen on account of their weight and pressure, and because they are contrary to their habits. Such objects are often a hindrance to hearing orders and are also a cause of accidents, as they diminish the perception of unusual sounds or cries of appeal from fellow-workers in danger. They must therefore be reserved for special cir-

cumstances where it is impossible to do without them, and as these circumstances are rather numerous, it is necessary to make a detailed examination of the procedure to adopt. As regards the ear plug there is no agreement on the best method of application. Should it be slack or compressed into the ears or should the ear be stopped as completely as possible by a tight plug impregnated with an oily substance? Ignorance on this subject is due to the uncertainty in regard to the respective rôles played by air and solid substances in sound transmission.

It is certain, however, that as far as fatigue is concerned the vibrations of the soil are an important, harmful factor. Hence, the use of anti-vibratory footgear or mats is to be recommended in all cases. An individual method, frequently extolled, is change of work, but this can easily be carried too far. Although excellent in itself when recommended for workers in a particularly unhealthy trade, it loses all its value in a well-defined trade. Take, for instance, the case of a flax spinner. Her work is of a special kind, requiring an apprenticeship of from three to four years at least, and consequently commands relatively high wages. What would a spinstress do if she were put to winding or reeling? But if a change of occupation is often impossible, a change of place in the same occupation is often easy, and with differences of intensity, resonance and height of noise in various parts of the same room or in different departments or buildings of the same industry, it is advisable and possible by a simple change of position to improve conditions for a susceptible person.

*Protective Measures Applicable to Working Conditions.*—Extensive and painstaking researches should be made in order to discover the best means of lessening industrial noise. The origin, intensity, height and rhythm of noise, the local circumstances which increase it, the vibrations which accompany it, etc., must be examined in detail. It is necessary to reduce the intensity as well as height and resonance. Among causes which aggravate are carelessness, lack of room, wrong use of apparatus, lack of upkeep and repairs, abuse of glass partitions, insufficient natural ventilation. But if it is true, as is sometimes claimed, that the internal ear is organized in such a way that each of its parts corresponds to a sound of definite height, it would be of value to vary as often as possible the tone of sound in a factory, and this is practicable in many cases. It has been observed that a sudden intermittent, and more or less irregular noise is more disagreeable to the ear, other conditions being equal, if produced in a quiet atmosphere than in a noisy one. Here we have practically the action of the natural organic defences still unknown as regards the ear. It is useful at times to compare certain machines making a continuous moderate noise with those making a loud noise when thrown out of gear. But before we can successfully apply prophylaxis to objects, we must know how far air conduction is harmful to the ear. If it were shown to be powerless to create alone a serious organic ear lesion, the practical means to apply would be principally against vibrations, and it would be necessary to have special regulations for the supporting structure of machines and foundations of factories, special platforms for the use of workers, etc.

## Conclusions

1. It is desirable that careful observations be made in order to remove the existing uncertainty in regard to the following points:

(*a*) Are lesions due to noise so localized that high and deep sounds act on different parts of the cochlea?

(*b*) Is air conduction in itself sufficient to cause in time lesions of the internal ear?

(*c*) What are the extreme limits of deficient hearing compatible with work in a noisy factory without examination by an ear specialist?

2. An international commission composed of doctors having access to all the factories of the country ought to decide the basis of an inquiry into industrial sounds, for the purpose of preparing a detailed account of the principal noisy industries.

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# THE REHABILITATION OF EMPLOYEES: AN EXPERIENCE WITH 1,210 CASES *

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ALTHOUGH the custom of making a physical examination as a preliminary to employment has become very common in recent years, there has grown up on the part of the employees a great deal of opposition and even hostility to this requirement. The object of the work here described has been to extend and make practical use of these examinations for the reconstruction of the employee — a procedure by which we believe that immense gains, both economic and in point of health, will be secured, and a kindlier feeling established.

The subject of salvage in general has become a matter of vast and recognized importance and the savings thus secured are enormous. We may, for example, see this process being carried on daily in the disposal of city waste: A broad, endless belt carries the waste down a long room. Workers on either side take off various articles for reclamation, and what is left is then swept on to the furnace. If, instead of city waste, this endless belt were carrying men and women, more or less disabled, and if, instead of ordinary workers, there were stationed by the sides physicians and specialists, would such wholesale human salvage be possible? Or would it be better merely to make a selection here and there of the best?

The results submitted in this article were secured from the analysis of 1,210 examinations made among the employees of a large department store. There are in all 2,000 employees in this establishment, 85 per cent. of whom are women. The average age is 27 years. The method of medical service in use in this store has been fully described in an earlier paper,† and therefore it is enough for the present to say that the physical examination has been supplemented by reports from specialists or from laboratory experts whenever such reports were needed. The general physical condition of these men and women, as disclosed by the study of the examination records, is shown in Table 1, new employees and old employees being grouped separately by way of comparison. In Table 2 the workers are arranged in groups by decades, in order to show more clearly the progressive deterioration suggested by the figures in Table 1. From the schoolchildren group to the group of workers over 40 years of age there is a steady deterioration from 75 to 99.3 per cent., the causes of which, in the experience of this service, are as follows: infection from fellow employees, persistent bad hygiene, and neglect.

TABLE 1. — DISTRIBUTION OF DEFECTS IN OLD AND NEW EMPLOYEES COMPARED

| Class | Total Number Examined | Average Age | No Defects | One Defect | Two Defects | Over Two Defects | Percentage Defects |
|---|---|---|---|---|---|---|---|
| New employees applying for work | 532 | 23½ | 14 | 78 | 152 | 288 | 97.3 |
| Old employees | 678 | 27 | 7 | 113 | 217 | 341 | 98.9 |

As to infection, it may be said that in the examinations analyzed the following diseases have been found: scarlet fever, diphtheria, measles, whooping cough, impetigo

* Received for publication Oct. 10, 1921.

† F. S. Kellogg: Medical Supervision of Employees, Penn. Med. Jour., 1920, p. 667.

contagiosa, scabies, pediculi, gonorrhea, syphilis, pneumonia, erysipelas, tuberculosis and an immense number of cases of diseased tonsils, acute and chronic, and an equally large number of foul teeth and septic mouths. Infection is very real and ever present; yet medical inspection has been limited to the schools.

TABLE 2. — DISTRIBUTION OF DEFECTS BY DECADES

| Group | No Defects | Defective | Per Cent. Defective |
|---|---|---|---|
| Schoolchildren | .... | ... | 75.0 |
| Under 20 years | 17 | 500 | 96.7 |
| 20 to 30 years | 10 | 371 | 97.4 |
| 30 to 40 years | 2 | 167 | 98.8 |
| Over 40 years | 1 | 142 | 99.3 |

Bad hygiene — that is, bad habits which will cause disability in time — is very common. Out of 425 cases which were investigated 359, or 85 per cent., were instances of bad hygiene. (Hygiene here does not include housing.) Neglect is even more common, indeed it is often the rule, as is evidenced by the fact that none of the forty-two cases of tuberculosis noted among the employees examined was on treatment, and also by the habitual disregard of treatment as shown by the figures given later in this paper (see Table 4).

The gravity of the defects noted in the examinations under discussion can be seen by reference to Table 3, in which are given the requirements in time for the rehabilitation of these employees. In contrast to the requirements and needs of these cases are the facts as to the actual treatment which the patients receive. The facts are ascertained as follows: On the completion of an examination and after reports from specialists have been received, it has been the custom to refer the patient for treatment to a hospital or to a specialist. In order that authentic reports of treatment may be received, the patient is given a report card with a stamped and addressed envelope. If treatment is secured, the report is received and noted on the patient's health record. If the report card is not returned, the patient is called again to the office and his case is followed up until he has received proper treatment. The amount of follow-up work needed is instructive: There were thus given to patients 1,054 report cards, after a complete physical examination, frequently supplemented by a careful examination by a specialist. The results were as follows:

| | |
|---|---|
| Number securing treatment without follow-up work | 62 |
| Percentage securing treatment without follow-up work | 5.9 |
| Number who had to be called to office repeatedly | 992 |

If, after a full examination and with expert advice, only 6 per cent. are led to secure treatment from competent hands,

TABLE 3. — REQUIREMENTS IN TIME FOR TREATMENT

| Requirements | Number of Cases | Per Cent. |
|---|---|---|
| No stopping of work required | 473 | 39.0 |
| From 1 to 10 days of hospital care | 573 | 47.3 |
| From 10 days to 1 month at hospital | 107 | 8.8 |
| More than 1 month at hospital or sanatorium | 55 | 4.5 |
| Incurable and unable to work | 2 | 0.1 |

what percentage would seek treatment when left entirely to their own initiative — the condition of general practice? Certainly it would be much less than 6 per cent. And of this small number what per-

centage would place themselves in competent hands? Or, being fortunate enough to find themselves in good hands, how many would remain on treatment long enough to secure any permanent benefits? It is evident that constructive treatment, such as is necessary for the rehabilitation of these employees, exists, if at all, in only a very small fraction of cases, and the progressive deterioration of the employee which has been shown is evidence of this fact.

The most impressive single fact brought out by the present study is the almost universal neglect of life and health. And yet the only means used at present for the reclamation of the disabled employee is the treatment which he secures upon his own initiative. The plan of leaving the sick or disabled employee to his own resources and trusting to his initiative is, therefore, a failure. If anything is ever to be done for the employee we have, then, as an alternative, medical supervision, either by the company or by the state.

## Experience with Medical Supervision

The experience here given covers a period of about two years, and includes a very great variety of diseases and disabilities. Treatment has not been made compulsory except in cases of tuberculosis and contagious diseases, including veneral diseases. Moreover, a case is considered and counted as having been treated only when the patient has been placed in a hospital, or in other thoroughly competent hands, and a report has been received on one of the cards already mentioned.

To report all the diseases and disabilities occurring among the employees of the department store under consideration would require an unduly long list. A few classes of diseases have, therefore, been selected in order to show the percentage of cases securing treatment. (Tables 4 and 5.) The low percentage attained in certain cases, such as diseases of the nose and throat, is to be explained by the fact that a very large number of operations have been recommended. Many of the cases which have not been treated as yet will, as a result of further work, have their defects corrected. It is to be noted, also, that although only

TABLE 4.—CASES TREATED UNDER MEDICAL SUPERVISION

| Disease | Number of Cases | Number Treated | Per Cent. Treated |
|---|---|---|---|
| Diseases and defects of eyes | 313 | 117 | 37.3 |
| Diseases of ears | 75 | 31 | 41.3 |
| Diseases of nose and throat | 691 | 91 | 13.1 |
| Bad teeth | 717 | 176 | 24.5 |
| Diseases of digestive tract | 94 | 24 | 25.5 |
| Orthopedic (employees stand at work) | 507 | 18 | 3.5 |
| Diseases of skin | 67 | 24 | 35.8 |
| Gynecological cases | 185 | 43 | 23.2 |
| Appendicitis | 11 | 7 | 63.6 |
| Diabetes | 2 | 2 | 100.0 |
| Diseases of nervous system | 6 | 3 | 50.0 |

forty-two cases were diagnosed positively as tuberculosis, there were 141 cases of suspected tuberculosis. Many of these, seventy-three in all, left the service of the company without allowing a careful study of their cases to be made. If all these cases had been carefully studied, it is certain that there would have been many more cases diagnosed as positive tuberculosis.

Although the general average of cases treated is not so high as we would hope to have it or so high as we expect to have it in

the future, it is to be noted that it is about 19 per cent. more than it would have been without medical supervision. And however earnestly we may desire a higher percentage of cases placed on constructive

TABLE 5. — TREATMENT COMPULSORY

| Disease | Number of Cases | Number Treated | Per Cent. Treated |
|---|---|---|---|
| Genito-urinary diseases | 12 | 10 | 83 |
| Syphilis (5 cases untreated) | 6 | 5 | 83 |
| Tuberculosis (diagnosis positive) | 42 | 30 | 71 |
| Suspected tuberculosis (diagnosis not made) | 141 | | |
| Contagious diseases | 6 | 6 | 100 |
| Pregnancy (including 1 case of toxemia of pregnancy) | 6 | 6 | 100 |
| Total defects noted | 2,906 | 577 | 19.8 |

treatment, we cannot secure these best results without educating the employees. They must be taught new and higher ideals of health. The very existence of a medical service, such as the one considered in this report, is the best way to teach these ideals. The constant contact with the medical department and the transformation effected in the lives of many of the patients will teach lessons which can be learned in no other way. The relief of recurring headaches and of the exhaustion of chronic ill health, the rejuvenation of the consumptive, the development of ability and talent blighted by disease — these benefits will give new standards of health, and secure hearty co-operation on the part of the employee.

## Conclusions

There is a progressive deterioration of physique in the group of employees here studied and presumably among working people in general. This deterioration is found to be due to infection from associates, to persistent bad hygiene, and to continual neglect.

The initial or sporadic examination cannot supply a healthy body of employees nor can it arrest this strong tendency to deterioration.

Medical supervision offers an effective means of securing the rehabilitation of employees, and salvage of large groups of men and women is thus practicable.

The time, therefore, is surely past when employer and physician, content to make a selection here and there, can watch with indifference the endless stream of more or less disabled men and women sweep by.

# TRINITROTOLUENE POISONING — ITS NATURE, DIAGNOSIS, AND PREVENTION

*Continued*

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## Field Investigation

THE principal purpose of the field investigation was to apply the knowledge gained from the study of T.N.T. poisoning in animals to the conditions prevailing in the factories. This work was done in a large shell-filling plant employing from 7,000 to 8,000 workers, and was made possible through the co-operation of both the management and the workers. The workers were employed in three shifts of eight hours each. The general sanitary conditions of this war settlement, such as housing, sewage disposal, water and food supply, were excellent. A hospital with a competent staff of physicians and nurses looked after the sick workers. On account of the high wages paid, the labor turnover was not large, a fact which made it possible to examine workers who had been exposed to T.N.T. for a long time. The workers of each factory unit were sometimes shifted from one job to another, but on the whole a considerable number were continuously exposed to T.N.T. The following brief remarks are intended to familiarize the reader with the conditions under which the T.N.T. worker is exposed to the poison.

### *Manufacture of High Explosive Shells*

The manufacture of high explosive shells varies with the type of explosive used. At the beginning of the war, T.N.T. was extensively used as the main charge. With the tremendously increased demand for these shells, it became necessary to supplement the deficient supply of T.N.T. by using a mixture of ammonium nitrate and T.N.T., commonly called amatol.

If T.N.T. alone is used, it is melted in large steam kettles at a temperature of about 85°C., and the molten explosive is then poured into the shells. Amatol is prepared by mixing from three to four parts of dry ammonium nitrate with T.N.T. at a temperature of approximately 90°C. The mixture, while still warm, is pressed into the shells by machinery (extruding machine). In order to understand the process of filling, the following description of the various parts of a high explosive shell is here given.*

The *shell* proper is made of hollow steel and fits snugly into the top of the cartridge. The *bursting charge* is contained in the shell and consists either of T.N.T. or amatol. A circular opening in the top of the shell is threaded so as to allow the adapter and booster to be screwed down into it.

The *adapter* is a device holding a narrow tube which in turn contains a narrower tube. The two tubes together constitute the *booster*. The adapter and booster are loaded with a mixture of tetryl (tetranitroaniline) and T.N.T. The *fuse* which is loaded with a sensitive explosive (mercury fulminate) is inserted at the top of the shell. The fuse is not inserted at the filling plant, but is put in before the shell is fired. The bottom of medium and large caliber shells contains a mixture of T.N.T., ammonium nitrate and ammonium chloride. This mixture ("smokemix") is used to produce smoke for the purpose of range observations.

The method of filling the shells in use at the plant where this investigation was carried out is essentially the following: The

* See "Ordnance and Gunnery" by Tshappat, Wiley & Sons, 1917.

empty shells are first painted in the empty-shell room. After this they pass to the pouring house containing three steam kettles in which the T.N.T. is melted. These kettles are provided with a hood connected with a vertical ventilating pipe which passes through the top of the roof. The hood has a window which permits the filling and emptying of the kettle. The workmen on this job are exposed to T.N.T. fumes and dust. The molten T.N.T. is poured into large ash cans, from which the shells are filled by means of hand dippers. The T.N.T. in the shells slowly crystallizes. The crust which is formed on the top is broken up in order to prevent cavity formation. This work is usually attended to by women. After all of the T.N.T. has crystallized the shells are put on trays and moved on rails to the finishing room, where the booster cavity is formed. This last process is done by pouring T.N.T. around a steel form inserted into the top of the shell. After cooling, the form is removed and the cavity is blown out with compressed air. The finishing room contains a steam kettle of the same construction as those in the pouring room. Finally the booster, containing the mixture of T.N.T. and tetryl, is inserted into the top of the shell. The loaded shells are transferred to the stenciling room, where they are labeled, weighed, and examined. From the stenciling room the shells pass to the magazine.

The booster plant is separated from the filling plant. The mixture of dry T.N.T. and tetryl is pressed into the booster by means of hydraulic presses. Amatol was used as the main charge until two months before this work was begun.

### *Incidence of T.N.T. Poisoning*

In the time at our disposal it was impossible to examine all T.N.T. workers in this plant. For this reason, 237 workers were selected at random and subjected to a thorough examination, special attention being given to the presence or absence of clinical manifestations of T.N.T. poisoning, such as cyanosis, icterus, and dermatitis. A specimen of urine was obtained from each worker, and this was examined for the presence of T.N.T. derivatives (Webster test), bile pigment and albumin. The blood was tested for its hemoglobin content by means of a Sahli hemoglobinometer standardized against a standard solution of hematin. The hemoglobin figures are therefore very reliable. The number and character of the red blood cells was determined. A white cell count and differential count were also made, and the number of nucleated red cells per 200 white cells counted. Information as to the length of exposure to T.N.T. and the type of work performed by each worker was obtained. The data pertaining to this work are compiled in the accompanying tables. Before proceeding to a discussion of these results, it is desirable to review briefly the work of other investigators interested in this subject.

Livingstone-Learmonth and Cunningham (28) relate their experiences in a shell-filling plant in Great Britain and call attention to the frequency of poisoning among thirty-six women workers as determined by clinical symptoms. They also report the blood and necropsy findings of a case of toxic jaundice. The blood in this case showed 4,400,000 red corpuscles, 9,320 white cells, 60 per cent. hemoglobin, absence of methemoglobin and nucleated red cells, no abnormalities in white cells.

Panton (24) examined fifty T.N.T. workers, some of whom had mild symptoms but were perfectly fit for work, with special reference to the blood changes. He stated that the red cells and hemoglobin were not adversely affected, with the exception of a slight degree of poikilocytosis. A moderate leukocytosis with a relative increase in the polynuclear neutrophils was noted in many cases. The blood serum often contained an

abnormal amount of bile pigment. Panton furthermore examined twenty-eight cases of toxic jaundice and six cases of so-called aplastic anemia. In the former group only four cases showed blood changes, these being characteristic of aplastic anemia. Panton suggests that moderate doses of T.N.T. might lead to a stimulation of the blood-forming organs.

Stewart (29) reports fourteen cases of toxic jaundice, in some of which the blood revealed an anemia of various grades. In nine cases a neutrophil leukopenia with lymphocytosis was noted.

Smith (30) examined twenty-five workers exposed to T.N.T. dust. A few showed slight cyanosis and complained of abdominal pains, but were otherwise perfectly fit for work. The lowest hemoglobin estimation was 75, and the red cell count was never below 4,400,000. No abnormality was noted in the character of the red cells. Most of the cases showed a moderate leukocytosis and increase in polymorphonuclear neutrophils. The platelets appeared normal.

Harrington (31) and Gregorson and Taylor (32) also report a small number of cases of T.N.T. poisoning.

Recently a paper appeared by Minot (33) in which the blood changes found in 233 T.N.T. workers are reported in great detail, as follows:

Red cell abnormalities were found to be very frequent. The most interesting abnormality was the frequent finding of fragmented or fragmenting red cells which have a definite histologic character. These cells appear to afford evidence of a rapid increased destruction of the red cells. Evidence shows that distinct increases of these cells are to be looked on as a significant sign of a considerable degree of poisoning; and probably when they occur in large numbers, they indicate some degree of toxic jaundice. Among other red cell abnormalities noted were the following: Polychromatophilia occurred in 83 per cent. of the cases, often to a marked degree. Howell-Jolly bodies, stippling and blasts were found, and increased numbers of reticulated red cells. The red cell count averaged in the mildest cases 4,500,000, and in the severest 3,800,000. It was found that there was usually a definite relationship between the total amount of red cell changes and the symptoms. Methemoglobin or some form of changed hemoglobin is apparent in these cases.

The white blood cells do not furnish as much information concerning the workers' condition as do the red cells. Slightly increased white cell counts were common. The observations showed that an individual may become distinctly and severely poisoned with a normal, or an absolute or relative increased lymphocyte count, or with an increased or normal polymorphonuclear count. However, lymphocytosis is to be looked on as an undesirable sign, but does not necessarily indicate that significant poisoning will occur or is occurring, except when there is a leukopenia. Slight eosinophilia (more than 5 per cent.) occurred in 10 per cent. of the cases. It was more common in cases with slight symptoms than in those with marked.

The blood platelets were usually slightly increased. Their diminution was observed twice and in both cases there was a relative lymphocytosis. Such a condition should certainly be regarded as evidence of a severe effect on the marrow, indicating aplasia. Webster's test for changed trinitrotoluene in the urine was found to be less valuable than blood examination to indicate the worker's condition.

Minot (33) (34) does not give much information as to the change in hemoglobin content of the blood. The few hemoglobin estimations referred to were made by the Tallquist method, which is very unreliable.

In its final report the Health of Munition Workers Committee of the British Ministry of Munitions (35) makes the following recommendations concerning the detection of the milder forms of T.N.T. poisoning:

. . . Care must be taken to avoid confusion with digestive disturbances due to other causes. Accounts given by patients may be unintentionally misleading. The yellow staining which normally occurs with T.N.T. cannot be taken as in itself a sign of poisoning. The following points are the more important indications of T.N.T. poisoning:

(*a*) Pallor of face and an ashen grey colour of the lips, tending to disappear if the worker becomes excited, as by medical examination. Sometimes the lips and tongue are purple in colour; the tongue is generally free from fur.

(*b*) The character and situation of the stomach pains.

(*c*) The presence of constipation and stomach distention.

The literature, therefore, shows that, with the exception of Minot, all writers rely principally on the presence of clinical symptoms for the diagnosis of T.N.T. poisoning. We cannot share this view, as our work has clearly shown that marked blood changes may be present in some workers in spite of the fact that they do not exhibit any cyanosis, pallor, or icterus. Table 1 reveals the significant fact that 72.5 per cent. of the workers showed an anemia of various grades. These cases are grouped into three classes as follows: (1) slight anemia, men with less than 84 per cent. hemoglobin or a red cell count below 4,000,000, and women with less than 80 per cent. hemoglobin or a red cell count below 3,700,000; (2) moderate anemia, workers with a hemoglobin content of from 60 to 71 per cent.; and (3) severe anemia, workers in whom the hemoglobin was below 60 per cent. According to Table 1, most of the anemia cases belong to the first and second groups, and only one case revealed the presence of a severe anemia. The red cell count of the anemia cases is very often normal or even above normal. The red cells of these cases are, however, abnormal, showing anisocytosis and poikilocytosis. This relatively high number of red cells is due to fragmentation and proves that a red cell count alone, in the absence of a hemoglobin estimation, is a very unreliable diagnostic index. Nucleated red cells were found in the circulating blood in 18 per cent. of the anemia cases. As regards the leukocytes, 4 per cent. of the cases with anemia showed a leukopenia, 22 per cent. a leukocytosis (count above 10,000), and 49 per cent. a relative lymphocytosis (mononuclears above 40 per cent.).

TABLE 1. — CLASSIFICATION OF CASES WITH ANEMIA

[Data compiled from an examination of 149 male and 88 female T. N. T. workers ]

| Degree of Anemia | Number of Cases | | | | | Hemoglobin in Per Cent. | | | | Erythrocyte Counts | | | | Cases with Poikilocytosis or Anisocytosis | Cases with Nucleated Red Cells in Circulation | Leukocytes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Males | | Females | | Males | | Females | | | | | | |
| | Per Cent. of Workers Examined | Males | Per Cent. of Males Examined | Females | Per Cent. of Females Examined | Average | Extremes | Average | Extremes | Average | Extremes | Average | Extremes | | | Cases with Count below 5,000 | Cases with Count above 10,000 | Cases with Relative Lymphocytosis |
| Slight ..... | 50.2 | 80 | 53.7 | 39 | 44.3 | 79 | 97–71 | 76 | 91 71 | 4,306,000 | 5,736,000<br>2,928,000 | 4,210,000 | 5,440,000<br>2,888,000 | 38 | 14 | 2.5 | 23 | 46 |
| Moderate ..... | 21.5 | 32 | 21.5 | 19 | 21.6 | 67 | 70–61 | 66 | 70 62 | 4,181,000 | 5,200,000<br>3,488,000 | 4,064,000 | 4,704,000<br>3,224,000 | 41 | 22 | 8.0 | 22 | 61 |
| Severe ........ | 0.4 | 1 | 0.7 | .. | . | 57 | 57 | . | . | 2,936,000 | 2,936,000 | | . | 0 | 0 | .. | 100 | 100 |

Both sexes show approximately the same percentage of anemia cases, a fact which indicates that sex has no influence on the susceptibility to T.N.T. poisoning. The same holds true in regard to the relation of the age of the workers to the susceptibility to anemia, as the latter appears in young, middle-aged, and old persons, the average age of the workers included in the three grades of anemia being approximately the same. (See Table 2.) In passing, it should be mentioned, however, that the British reports refer to the greater susceptibility of persons under 18 years of age. We were unable to verify this observation as the factory regulations prohibited the employment of persons below 18 years of age.

There is no consistent relation between the time of exposure and the susceptibility to anemia, a fact which is probably best explained by variations in the individual susceptibility of the workers to T.N.T. poisoning. It will be recalled that a very marked difference in individual susceptibility was also observed in dogs, and there is no reason to doubt that it may likewise occur in man. Moore (7) attributes this difference in susceptibility to differences in the permeability of the skin to T.N.T. We believe that this factor may partly account for these differences, but not entirely. It cannot be denied that the skin of various individuals shows a considerable variation in permeability to certain poisons. This was very well proved in the case of a number of war gases. It is to be kept in mind, however, that it was shown in the previous section of this report that dogs exhibited a marked difference in susceptibility, even when differences in the absorption of T.N.T. were completely excluded. Under these conditions the variation in individual susceptibility is very likely due to differences in the methods of dealing with the poison on the part of the body, in the manner indicated in the experimental section.

Only 48 per cent. of the anemia cases showed the presence of cyanosis of the lips. This observation is in conformity with the observations made on dogs with chronic T.N.T. poisoning. Here it was also shown that cyanosis of the oral mucous membrane is often absent in spite of the presence of a moderate to severe degree of anemia. Pallor of the skin was noted in 39 per cent. of our cases showing anemia.

A considerable number of the workers without anemia exhibited certain blood abnormalities and the presence of cyanosis or pallor. (See Table 3.) This would indicate that T.N.T. was absorbed by these workers, but obviously not in sufficient quantity to produce an anemia or toxic jaundice. In these cases blood regeneration was able to overcome any increased blood destruction caused by the poison.

TABLE 2.—RELATION OF ANEMIA TO AGE, TIME OF EXPOSURE TO T. N. T., AND CYANOSIS

[Data compiled from an examination of 149 male and 88 female T. N. T. workers]

| Class | Age in Years | | Time of Exposure in Days | | Number of Cases with Cyanosis and Anemia | | | Number of Cases with Pallor and Anemia | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average | Extremes | Average | Extremes | Per Cent. of Total Number of Cases | Males | Females | Per Cent. of Total Number of Cases | Males | Females |
| Slight anemia | 28 | 18–70 | 122 | 8–545 | 45 | 46 | 8 | 33 | 28 | 11 |
| Moderate anemia | 30 | 18–53 | 102 | 8–390 | 55 | 21 | 7 | 49 | 16 | 9 |
| Severe anemia | 20 | 20 | 24 | 24 | 0 | 0 | 0 | 0 | 0 | 0 |

The urine of these workers never contained even traces of bile pigment, and icterus was always absent. In no case did the urine contain sugar, and in a few cases only, a moderate amount of albumin was found. The urinary Webster test was made in a large number of cases and was nearly always positive. There was no relation between the intensity of the test and the anemia. The detailed account is therefore omitted. The Webster test has no diagnostic value beyond showing that T.N.T. is absorbed and excreted in a modified form. A few of the workers complained of shortness of breath and palpitation following slight exertion. Others complained of itching of the skin of the forearms and face, and in a few workers a typical papillar dermatitis was observed. The skin of the hands often shows a yellow staining due to

T.N.T. The hair of some workers assumes a reddish-yellow discoloration.

To sum up, it can be said that nearly three-fourths of the workers examined showed definite signs of poisoning. For the detection of poisoning the physician cannot rely altogether on symptoms, but he should also make a blood examination. Much valuable information can especially be gained from an accurate hemoglobin estimation. A standardized Sahli hemoglobinometer is recommended for this purpose.

*Preventive Measures*

In the manufacture of T.N.T. and in the filling of shells with this substance, it is almost impossible to prevent all contact of the workers with this poison. A certain amount of vapor is always formed in the heating of T.N.T., and unless rigid precautions are taken this vapor escapes to some extent into the workrooms, where it condenses to a fine dust which settles slowly. It is also impossible to prevent completely the spilling of either the molten or solid explosive, with the result that the floor, machinery, and the outside of the shells are more or less contaminated with T.N.T. Hence the workers may absorb the poison through the skin or the poison may enter the body with the inspired air. In this latter case part of the substance may be swallowed and absorbed from the gastro-intestinal tract. On account of the absence of a method for the determination of the absolute amount of T.N.T. absorbed by the skin of the workers, it is impossible to estimate the relative importance of skin absorption and absorption by the respiratory and gastro-intestinal tracts. Moore and his colleagues are inclined to attribute all T.N.T. poisoning to skin absorption. This view is altogether too one-sided, as the estimation of the air contamination made by Professor Phelps and Mr. Casselman of this laboratory plainly proves that under certain conditions the workers take in a considerable amount of the poison with the inspired air. For this reason it is safer to take the necessary precautions against both methods of absorption. The same position in regard to this matter is taken by the British Health of Munition Workers Committee in its final report.

TABLE 3. — BLOOD CHANGES AND SYMPTOMS IN WORKERS WITH AND WITHOUT ANEMIA

| | Cases | Poikilocytosis or Anisocytosis | Nucleated Red Cell | Leukocytes Below 5,000 | Leukocytes Above 10,000 | Relative Lymphocytosis | Cyanosis | Pallor |
|---|---|---|---|---|---|---|---|---|
| With anemia | 174 | 39 | 18 | 4 | 22 | 49 | 18 | 39 |
| Without anemia | 66 | 32 | 6 | 0 | 15 | 52 | 36 | 27 |

*Absorption of T.N.T. by Skin*

In view of the importance attached to skin absorption in the production of T.N.T. poisoning, it appeared desirable to determine the skin area actually exposed to the poison.

Several hundred workers, both men and women, were examined by testing the skin of the various parts of the body with alcoholic sodium hydroxide (Webster's reagent) and noting the intensity of the color so obtained. This varied from a very deep purple to a negative finding, and differed considerably on the same body surfaces in different individuals. As a general rule the reaction is most intense on the palms of the hands and about the ankle region. Next in

line comes the dorsal surface of the hand, the wrist, the foot below the ankle, the forearm, the neck, and the face, in the order named. The reaction is rarely positive on other parts of the body.

The skin area exposed to T.N.T. in female workers was as a rule not so extensive as that of male workers, which is due to the facts that the former are more particular in wearing clean overalls, underwear, and gloves, and that they bathe more frequently than the average male worker. This conclusion was reached from information volunteered by the workers, and from inspection of the change houses and living quarters.

The important practical point brought out by these tests is that the clothing and overalls protect the covered skin very efficiently against contact with the poison. The only exception in this respect concerns the ankle region. The poison gained access to this skin area on account of the fact that overalls of these workers did not cover the upper part of the shoes, and thus permitted T.N.T. dust to penetrate the stockings above the shoes. In order to avoid this the worker should be required to wear overalls which cover not only the legs but also the ankles.

The use of leather gloves seems to be of little protective value, as most of the workers remove them from time to time, thus allowing the inside of the gloves to become covered with T.N.T. Under these conditions skin absorption is probably favored instead of reduced, especially during the warmer seasons when excessive perspiration might aid it. The use of gloves should therefore be discouraged.

The British official reports refer to the failure experienced in the use of skin varnishes in the prevention of skin absorption. In several cases varnishes gave very unsatisfactory results. Dr. George F. White of this laboratory has experimented with a shellac castor-oil varnish which appears fairly satisfactory for this purpose, but its trial in the factory was impracticable.

Further work was done in order to discover an inexpensive, harmless, and efficient skin wash which might prove satisfactory in removing T.N.T. from the skin of the workers before they left the factory. It is obvious that such a skin wash might considerably reduce, possibly by two-thirds, the amount of T.N.T. absorbed by the skin, as the worker would no longer absorb the poison after leaving the factory. The regulations in this plant required that the workers should wash their hands and faces very thoroughly with soap and water after stopping work, and they were also advised to take a shower bath. Excellent wash houses were available for this purpose, but the instructions were only partially carried out. It was furthermore found that soap and water do not remove all the T.N.T. from the skin even after thorough and repeated washing. Numerous experiments were then carried out to determine the solubility of T.N.T. in various solvents. The most promising solvent seemed to be a 10 per cent. sodium sulphite solution. This wash was tested out on T.N.T. workers in the following manner:

Thirty-six workers volunteered for this experiment. They were asked to wash their hands and forearms very thoroughly, first with soap and water, and then with 10 per cent. sodium sulphite in water. The presence or absence of T.N.T. on the skin previous to and after the washing with soap and the sulphide was determined by means of alcoholic sodium hydroxide (Webster's reagent). The results are illustrated by Table 4. It is evident, then, that washing of the skin with soap and water removes only a relatively small portion of T.N.T. After washing in the sodium sulphite, however, the test for T.N.T. became negative in practically all cases except where the washing had not been very thorough.

In order to gain some information as to the actual amount of T.N.T. removed by the sulphite wash, the following experiment was carried out: Four T.N.T. workers were asked to wash their hands and forearms thoroughly with soap and water. After this they washed a second time in a liter of 10 per cent. sodium sulphite, care being taken to prevent spilling of the solution. The sulphite solution assumed a dark red color and was analyzed for T.N.T. in the following manner. The solution was acidified with dilute sulphuric acid and extracted twice with ether. The ether extract was washed twice with distilled water and the ether evaporated to dryness. The crystalline residue, after drying to constant weight, weighed 148 mg. and consisted of T.N.T. It is, therefore, evident that at least 37 mg. were removed from the hands of each worker.

The workers who used the sulphite wash were enthusiastic over the efficiency of this chemical for the removal of T.N.T. and made inquiries as to where they could procure it. The reason for the great interest on the part of the workers is that the deep red color which appears on the skin after treatment with sulphite clearly proves to the worker the presence of T.N.T. on his skin, and the fact that the color passes into the solution visualizes the removal of the poison from the skin. There is no objection to the use of the sulphite solution for washing the face and neck, as animal experiments have demonstrated that this solution has no injurious effect on either the skin or the eyes.

TABLE 4.—RELATIVE EFFICIENCY OF SOAP AND WATER AND SODIUM SULPHITE SOLUTION IN REMOVING T. N. T. FROM SKIN

| No. of Worker | Webster Test before Washing | | | Webster Test after Soap and Water | | | Webster Test after Sulphite | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hands | Wrist | Forearms | Hands | Wrist | Forearms | Hands | Wrist | Forearms | |
| M. K. 471 | + + + + | + + + | + | + + | + | + Sl | . . . | . . . . | . . . . | End of shift. |
| M. D. 647 | + + + | + + | + | + + | + | + Sl | . . | . . . . | . . . . | " " " |
| L. I. 358 | . . . . . . | . . . . . . | . . . . . . | + + | + | . | | . . . . | . . . . | " " " |
| L. E. 543 | + + + + | + + + | + + | + + | + + | . | . | . . . . | . . . . | " " " |
| M. K. 85 | + + + + | + + | + | + + | – | + Sl | . . | . . . . | . . . . | " " " |
| L. D. 314 | + + + + | + + | + | + + | + | . | . . . | . . . . | . . . . | " " " |
| L. K. 401 | . . . . . . | . . . . . . | . . . . . . | + + | + | | | . . . . | . . . . | Had been off T. N. T. two weeks; worked on day of test. |
| L. K. 192 | + + + + | + + + | + | + + + | + | + Sl | . . . . | . . . . | . . . . | End of shift. |
| L. I. 562 | + + + + | + + | + | + + + | + + | + | + Sl | + Sl | . . . . | " " " |
| L. I. 488 | + + + | + + | + | + | + Sl | . . | + Sl | . . . . | . . . . | Did not wash thoroughly. |
| L. I. 276 | + + + + | + + + | + + | + + | + + | . | + Sl | . . . . | . . . . | " " " " |
| L. H. 615 | + + + + | + + + | + + | + + | + | + Sl | . . . | . . . . | . . . . | " " " " |
| X | + + + | + + | + | + + | + | + | + Sl | . . . . | . . . . | " " " " |
| X | + + + + | + + + | + + | + + | + | . | + Sl | . . . . | . . . . | " " " " |
| L. I. 591 | . . . . . . | . . . . . . | . . . . . . | + + | + | + | . . . . | . . . . | . . . . | " " " " |
| L. I. 505 | . . . . . . | . . . . . . | . . . . . . | + + + | + + | + | . . . . | . . . . | . . . . | " " " " |

## *Absorption of T.N.T. by Lungs and Gastro-Intestinal Tract*

In order to prevent as much as possible the absorption of T.N.T. by the lungs and gastro-intestinal tract, the workrooms should eliminate the possibility of air contamination with T.N.T. In the factory in which this work was carried out, three operations exposed the workers to badly

contaminated air. First of all the melting of T.N.T. in the steam kettles led to the escape of a considerable amount of the vapor into the workroom as the kettle hoods were not provided with forced draft. The workmen engaged in melting were therefore breathing air more or less saturated with T.N.T. vapor, which, according to the analyses reported by Professor Phelps and Mr. Casselman,* contained 0.006 mg. of T.N.T. per liter. The worker would therefore breathe at least 16 mg. of T.N.T. during seven and one-half hours. Another operation which led to air contamination was the sweeping of the floors, which was done three times during the day while the workers were at work. The dust suspended in the air by means of this operation is very light and settles slowly. As the result of the sweeping, each worker would breathe in approximately 9.1 mg. of T.N.T. during a day. The third objectionable operation consisted in blowing out the booster cavity with compressed air. This was done very frequently in the finishing room, and the persons on this job may take in 2 or 3 mg. of T.N.T. with each breath. These serious health hazards could easily be eliminated by the use of exhaust ventilators for the melting kettles and an appropriate vacuum system for the cleaning of the floors and the booster cavity.

The figures given in the report of Professor Phelps and Mr. Casselman are convincing enough to emphasize the importance of preventing air contamination. The method used was much more accurate than the one used by Moore and his colleagues, a fact which explains the higher values thus obtained.

As a further precaution, the workers should be urged to wash their hands thoroughly before eating their meal during the working hours. The protective value of respirators has been tested out extensively in this country and abroad, and has been found to be very unsatisfactory.

This investigation, therefore, clearly proves the necessity of guarding the worker against absorption of the poison by the skin as well as by the lungs and gastrointestinal tract.

### *Diet*

In the first part of this paper attention was called to the relation between diet and T.N.T. poisoning. It was pointed out that dogs on a meat diet are more resistant to the action of T.N.T. than dogs fed on bread and milk. In view of this observation it was important to make inquiries concerning the diet of the workers.

The company operates two mess halls, one principally for women, the other for men. In both of these a fixed menu is served. There is also a "short-order" restaurant where the workers can choose their menu from a large variety of foods. The portions served in these mess halls are fairly liberal. The menus vary but little from week to week.

A relatively small number of the workers live in family cottages and procure their provisions from the company's commissary store.

It was evident that the diet of the workers was varied and that it included a considerable amount of meat, vegetables, cereals, bread, butter, and fruits. The good quality of the diet consumed by the workers may be one of the factors which accounts for the evident absence of severe T.N.T. poisoning in this plant.

### *Toxic Jaundice and Aplastic Anemia*

The first cases of toxic jaundice attributed to T.N.T. were reported in 1915 by the medical inspectors of factories to the British home office, which in turn issued instructions to physicians to report all such cases. According to O'Donovan (36) there occurred in England, in 1916, 181 cases

* The report by Professor Phelps and Mr. Casselman will be published elsewhere.

with 50 deaths; in 1917, 189 cases with 44 deaths. In addition there were reported during this period 14 cases of aplastic anemia, these cases being regarded as representatives of another extreme form of T.N.T. poisoning. No statistics are available as to the prevalence of these two conditions in the United States. Martland (5) and Haythorn (37) report two fatal cases, giving also the pathological findings at necropsy. Hamilton (38) (39) reports 13 deaths from T.N.T. poisoning in the United States, but fails to state the nature of the clinical picture, whether toxic jaundice or aplastic anemia.

It is very significant that the occurrence of toxic jaundice and aplastic anemia in T.N.T. workers is relatively rare when it is considered that Great Britain alone employed over 100,000 persons in the manufacture of munitions. It is also to be remembered that the diagnosis of toxic jaundice depends largely on the icterus, which of course is not characteristic of this condition only, and the association of the worker with T.N.T. Syphilitic icterus, or true yellow atrophy of the liver, may occur in T.N.T. workers and may thus lead to a diagnosis of toxic jaundice. The same holds true for aplastic anemia, a disease which also occurs in persons not exposed to T.N.T. It is therefore possible that the figures given by O'Donovan are somewhat too high.

The question naturally arises as to why most of the T.N.T. workers should be immune to toxic jaundice and aplastic anemia. The following considerations may assist in the solution of this problem. From the results obtained in the study of T.N.T. poisoning of dogs, it is evident that T.N.T. often causes the appearance of a very severe anemia. The bone marrow of these animals is hyperplastic without exception, and for this and other reasons the anemia as observed in these animals cannot be regarded as a true aplastic anemia. The blood destruction was therefore attributed to a primary injury of the red cells leading to fragmentation and eventually to phagocytosis of the injured red cells by the phagocytic cells of certain organs. The examination of the T.N.T. workers has furthermore revealed the fact that a considerable number show a moderate anemia. Minot has also called attention to the fragmentation of the red cells in many T.N.T. workers.

We therefore believe that the available evidence clearly shows that the mechanism of the blood destruction caused by T.N.T. is essentially the same in dogs and in man. Previous writers on this subject insist, however, that T.N.T. anemia is caused by the toxic action of T.N.T. or some of its derivatives on the hematopoietic organs, especially the bone marrow. Our data do not permit us to exclude this possibility altogether, although they do show that T.N.T. anemia is essentially a phagocytic anemia. The bone marrow was examined only in six cases of so-called aplastic anemia in T.N.T. workers. The marrow of the femur was described as gray in one case, fatty with pink spots in two cases, and pale pink in two cases. Turnbull (40) from the microscopic examination of the bone marrow in one case, claims that it showed a relative excess of erythroblastic activity and a decrease in the number of megalokaryocytes; numerous plasma cells and large phagocytes containing pyknotic nuclei, erythroblasts, erythrocytes, and iron-containing pigment. It is possible to conceive that in the later stages of the anemia the function of the bone marrow may be seriously depressed on account either of the oxygen deficiency or of other metabolic abnormalities resulting from the severe anemia, or as the result of the direct action of the poison on this organ. We believe, however, that these factors are of minor importance in the production of T.N.T. anemia.

As to T.N.T. icterus, the experimental

work plainly shows that this condition may often occur in the absence of liver necrosis or atrophy, in which case the icterus is probably due to the inability of the liver cells to excrete the increased amount of bile pigment resulting from the destruction of erythrocytes. Some of the cases of toxic jaundice reported by Panton (24) may possibly be explained on this basis. The blood of these patients showed a normal hemoglobin content and red cell count. On account of these findings some writers explain T.N.T. icterus as being primarily due to the injurious action of the poison on the liver cells, a view which is not necessarily correct as it is quite possible to conceive that T.N.T. may lead to a considerable increase in red cell destruction and consequently bile pigment formation, without causing a reduction in the hemoglobin content or number of red blood cells. The hemoglobin content and red cell count are not an absolute index of the degree of blood destruction, as increased blood regeneration may temporarily compensate the increased disintegration of red cells. Some of Panton's cases which he observed for several weeks showed a gradual decrease in hemoglobin and the number of red cells, this finally resulting in the appearance of a severe anemia. It is very likely that in the early stages of the jaundice the increased blood destruction was compensated by regeneration, and that later on, when this compensation failed, the anemia appeared.

It is therefore possible to attribute the icterus in some of the toxic jaundice cases to the increased blood destruction caused by T.N.T. In other cases, however, the icterus is associated with a marked reduction of liver dullness during life, and at necropsy the liver shows extensive necrosis and atrophy, which, according to Turnbull, Haythorn, and others, cannot be distinguished from acute yellow atrophy. The liver was examined in thirty of these cases and in all a greater or less degree of acute yellow or red atrophy was present. The liver cells of some areas were completely destroyed. Some observers also found a moderate amount of cirrhotic change. It is difficult to determine whether or not T.N.T. alone is responsible for these liver changes. We are rather inclined to explain these cases by assuming that certain preexisting pathological conditions affecting the functional capacity of the liver, such as cirrhosis, syphilis, alcoholism, etc., may predispose some T.N.T. workers to toxic jaundice in an abnormal degree. Under these circumstances, it is possible to conceive that T.N.T. or its reduction products may exert a more deleterious action on the liver cells than in persons with normal livers. This explanation would account for the fact that in numerous experiments with dogs it was impossible to produce even the slightest degree of liver atrophy, and this in spite of the fact that these animals are highly susceptible to necrosis of the liver when exposed to poisons with a more or less specific action on the organ, such as chloroform, phosphorus, and arsenicals.

The fact that toxic jaundice sometimes appears in T.N.T. workers several weeks after their removal from all contact with T.N.T., agrees with the observation made on dogs, *viz.*, that T.N.T. is very slowly eliminated from the body, and therefore continues to exert its toxic action for a long period of time.

If the correctness of these considerations is taken for granted, the prevention of toxic jaundice and so-called aplastic anemia in T.N.T. workers should concern itself principally with the elimination of all persons with evidence of liver disease and anemia from contact with T.N.T. Moreover, all T.N.T. workers should be frequently examined by the factory physician, special attention being given to the occurrence of a slight icteric change of the conjunctiva or skin, the presence of this symptom being regarded as sufficient reason to put the in-

dividual on work where he is no longer exposed to T.N.T. An accurate hemoglobin estimation should also be made on each worker every week, or at least every two weeks. A nurse or specially trained laboratory assistant could easily attend to this work. Any workers with icterus or severe anemia should be admitted to a hospital. The treatment should consist first in the removing of all T.N.T. from the body surface by means of a 10 per cent. sodium sulphite solution. The anemic patients should receive a nutritious diet containing a fair amount of fresh meat. The patients with jaundice should be treated with laxatives and should be fed on a meat-free diet containing milk and fresh vegetables.

The prognosis of cases with an extreme anemia is grave. A considerable number of cases with jaundice recover, although the recovery proceeds very slowly and requires six months or more. See Crawford (41) and Bower (42).

*Summary*

The principal results obtained in the field investigation are the following:

The examination of 237 T.N.T. workers in a shell-filling plant showed that 72 per cent. of these workers were anemic. This anemia exhibits the same features as the anemia observed in dogs poisoned with T.N.T., *viz.*, a reduction in the hemoglobin percentage, the presence of anisocytosis and poikilocytosis, polychromatophilia, fragmentation of red cells, and the appearance of nucleated and reticulated red cells in the circulating blood. The anemia may or may not be associated with a leukocytosis, leukopenia, or relative lymphocytosis.

Cyanosis, pallor, and dermatitis were frequently seen in these workers, and indicate that the poison is absorbed. The absence of these symptoms, however, is not proof of the absence of poisoning. A marked anemia may exist without clinical symptoms.

Examination of the urine nearly always reveals the presence of a derivative of T.N.T. (hydroxylamine compound). The presence or absence of this substance in the urine, as determined by the Webster test, is of no prognostic value. The examination of the blood, with particular reference to its hemoglobin content, the character of the red cells and the appearance of a slight icteric discoloration of the skin or conjunctivae, is recommended as a reliable guide for the diagnosis of T.N.T. poisoning.

No cases of toxic jaundice or aplastic anemia were found among these workers. It is suggested that the so-called aplastic anemia observed in T.N.T. workers represents the final stage of the anemia so commonly found in persons exposed to T.N.T., and that in the earlier stages of poisoning the blood destruction is essentially due to the injury of the red cells which secondarily leads to phagocytosis of the injured cells by the spleen, liver, and bone marrow. In toxic jaundice the hemoglobin and red cell count may be normal or reduced. In the first case blood regeneration probably compensates for blood destruction. The liver lesions found at necropsy may be due to a pre-existing functional or histological abnormality of the liver cells which has been aggravated by the T.N.T. intoxication.

The poison may be absorbed through the skin, the lungs, or the gastro-intestinal tract. Means of prevention should be strictly observed. Skin contact and air contamination should be reduced to a minimum. The principal measures for skin protection should consist in wearing clean overalls and head dress, and in using sulphite solution for the removal of T.N.T. from the exposed skin surface before the worker leaves the factory. Personal cleanliness in working and in the care of the body should be emphasized. Gloves and

respirators are of no value. There should be efficient ventilation of the workrooms; the floors, booster cavities, etc., should be cleaned by means of an induced draft. The workers should be instructed to eat a nutritious diet containing a fair amount of meat. They should be examined at least every week or two for the presence of clinical symptoms and anemia. Intermittent employment on T.N.T. work reduces the health hazard somewhat, but does not necessarily insure against poisoning because the system retains T.N.T. for a considerable length of time. Preliminary medical examination should insure, as nearly as possible, that no person is employed who shows the slightest evidence of liver disease or anemia.

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# BOOK REVIEWS

**The Health of the Industrial Worker.** By Edgar L. Collis, B.Ch., M.A., M.D. (Oxon.), M.R.C.P. (Lond.), M.R.C.S. (Eng.), Mansel Talbot Professor of Preventive Medicine, Welsh National School of Medicine; Member of Industrial Fatigue Research Board; late H.M. Medical Inspector of Factories; Member of Health of Munition Workers Committee; Milroy Lecturer, R.C.P. (1915); Director of Welfare and Health, Ministry of Munitions; and Major Greenwood, M.R.C.P. (Lond.), M.R.C.S. (Eng.), Member of Industrial Fatigue Research Board; Reader in Medical Statistics, University of London; late Statistician to Lister Institute; Head of Medical Research Branch, Ministry of Munitions; Arris and Gale Lecturer, R.C.S. (1908). Containing a chapter on RECLAMATION OF THE DISABLED by Arthur J. Collis, M.A., M.D. (Cantab.), M.R.C.S. (Eng.), D.P.H. (Durh.), Medical Superintendent, Ministry of Pensions Hospital, Leicester; late Temp. Lieut.-Col. R.A.M.C. With an introduction by Sir George Newman, K.C.B., D.C.L., M.D., F.R.C.P. Illustrated. Cloth. Pp. 450 with illustrations and index. Philadelphia: P. Blakiston's Son & Co., 1921.

Sir George Newman in his introduction to this book gives the point of view which it so forcibly presents: "While at first sight accidents, poisoning, and a high occupational death rate are impressive, it cannot, I think, be doubted that the less dramatic side of the problem is, in fact, the more important — namely, the lost time and incapacity due to ill-health. For this is so widely prevalent as to be almost universal, in all districts, at all ages, in all trades, there is this vast mass of wasted life and energy due for the most part to preventable maladies — in their turn largely attributable to remediable conditions of industry, or to neglect of hygiene."

After reading this introduction one is not surprised to find an absence of chapters upon industrial toxicology and upon the minutiae of industrial medicine and surgery. We are offered instead a view of a new field in preventive medicine, a field which covers the working life of a large portion of our population. Such a book places industrial hygiene in its proper place, displays its possibilities of growth, and removes it from the position of a rather feeble adjunct to pharmacology and to the established practice of medicine and surgery.

The chapter headings will give the best idea of the scope of the work: I. Industry and Health — A Retrospect; II. Review of Industrial Legislation; III. The Utilization of Statistical Methods in Industrial Preventive Medicine; IV. The Effects of Industrial Employment upon Health as Indicated by Vital Statistics; V. Industrial Activity and Fatigue; VI. Tuberculosis and Industry; VII. Cancer and Industry; VIII. Causation and Prevention of Accidents; IX. Industrial Employment of Women; X. The Feeding of the Industrial Worker; XI. Food at the Factory; XII. The Use of Alcoholic Beverages by the Industrial Worker; XIII. Reasons for and Methods of Ventilation; XIV. Lighting; XV. Washing Accommodation — Sanitary Accommodation — Drinking Water — Working Clothes — Cloak Rooms — Seats; XVI. Labour Turnover or Industrial Wastage; XVII. Supervision of Industrial Health; XVIII. Reclamation of the Disabled.

The treatment of these subjects is of high order and the difficulty of handling them is great because in the main they are at the beginning of their development. Of particular merit are the chapters upon fatigue, ventilation and tuberculosis. The addition to each chapter of well-selected groups of references is an addition of value and especially useful in a developing subject.

While to the American reader it may seem that the treatment should have extended outside British experiences to a greater degree than occurs, this does not seem of importance to the reviewer. The book is an exposition of principles, of a modern point of view upon which schools may be founded. In such an effort the experiences recounted are necessarily international in their applicability and significance.

It is a pleasure to recommend the work to forward-looking readers, and it is hoped that those who have seen the subject of industrial hygiene as the weak handmaid of medicine and surgery will find a stimulating refutation of their views in this volume. — *Cecil K. Drinker.*

## BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

**Principles of Hygiene.** A Practical Manual for Students, Physicians, and Health-Officers. By D. H. Bergey, A.M., M.D., Dr. P.H., Assistant Professor of Hygiene and Bacteriology, University of Pennsylvania. Illustrated. Cloth. Seventh Edition, thoroughly revised. Pp. 556 with illustrations, preface, index, and appendix. Philadelphia and London: W. B. Saunders Company, 1921.

**Textbook of Surgical Nursing.** By Ralph Colp, A.B., M.D., Instructor in Surgery, Columbia University, New York; Lecturer in Surgical Nursing, Presbyterian Hospital Training School for Nurses, New York; Adjunct Visiting Surgeon, Volunteer Hospital, New York; Chief of Surgical Clinic, Beth Israel Hospital, New York; Formerly Lecturer in Nursing and Health, Teachers College, Columbia University, New York; and Manelva Wylie Keller, B.S., R.N., Formerly Chief Operating Room Nurse, St. Luke's Hospital, New York, and Anesthetist, St. Luke's Hospital, New York, and Mobile Hospital No. 2, A. E. F., France. Cloth. Pp. 453 with appendix, illustrations, and index. New York: Macmillan Company, 1921.

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## MODERN VIEWS UPON THE DEVELOPMENT OF LUNG FIBROSIS*


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### I. NEW ASPECTS OF THE PROBLEM

IN 1918 Haldane (1) published a short and very suggestive paper on the cause of serious lung injury from dust. He pointed out that silicious dust had been thought to be harmful if present in the air in any considerable amount, but that he had become acquainted with certain instances in which this did not seem to be true, work in high percentages of silicious dust being apparently uninjurious. He then discussed the fact that coal miners who breathe coal and shale dust remain comparatively free from serious lung disease. This he harmonized with experimental work done by Mavrogordato (2), who caused guinea-pigs to breathe air laden with six different dusts: coal, shale, quartz from the Transvaal, flint, material from flues, and pure precipitated silica. He found that high concentrations of any of these dusts resulted in heavy deposition in the lungs, with marked congestion and cellular proliferation. His observations did not continue long enough to permit the widespread development of fibrous tissue, but there is apparently no doubt that it would have occurred.

The significant fact of the experiments was brought out by moderate exposures, when it was found that "While coal dust and shale dust enter the lung with great readiness they do not produce, under these conditions, permanent lesions; and the lung might pass for normal after a twelvemonth. Flue dust and crystalline silica are not eliminated with such readiness." The important suggestion of the experiments is, then, that dusts which do harm are those which for some reason or other are not eliminated. Carbon particles, according to Haldane and Mavrogordato, cause rather a violent reaction when they reach the pulmonary alveoli, which results in their quick seizure by phagocytes and their elimination; while crystalline silica, a notably harmful dust, enters the lung with equal readiness, causes little reaction, remains in the lung tissue and slowly induces fibrosis.

It will be shown later that Mavrogor-


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dato makes many claims as to the manner in which dust is removed from the lungs, which are out of accord with the observations of other investigators. But analytical disagreements have nothing to do with his most important contention, namely, that rate of dust invasion is not more important than rate of dust elimination. When dust reaches the lung alveoli there are three ways by which it may get out:

1. By the bronchi—the route taken on coming in. The sputum of individuals who have worked in coal dust invariably shows particles, and a fair percentage of these have probably been down in the lungs and up again. They are noticed clinging to bits of mucus or within large cells which are constantly, but apparently erroneously, thought to be desquamated epithelial cells from the pulmonary alveoli. Later on the real origin of these cells will be discussed, but at this point it is enough for us to realize that dust particles in the alveoli may be seized by phagocytes which, by ameboid movement, find their way up into the bronchi and then, through the activity of the bronchial cilia, are driven up into the mouth. No doubt, also, the alveoli may fill with semi-fluid exudate which carries particles up on to the cilia, and thence they may be slowly passed on to the mouth.

2. The particles may get through the alveolar walls, reach the lymphatics of the lungs, and be slowly moved toward the lung roots. Present indications point to this second possibility as of most importance.

3. The particles may be taken up from the alveoli by phagocytes which wander into the blood capillaries surrounding the alveoli, and then be carried to various points of elimination. Permar (3) mentions this possibility and feels that it does not occur. While we must admit that there is no direct proof of the removal of foreign material by the blood, there is a certain amount of analogous evidence which is worth considering. Winternitz and Smith (4) have shown that physiological salt solution may be poured into the alveoli of the dog at a rate as high as 3,000 c.c. in 30 minutes. Undoubtedly, removal of this fluid is accomplished by the blood stream. So far as we know there are no direct attempts to ascertain whether solid particles may be removed by the same route. In 1916 Shipley and Cunningham (5) performed experiments which are most suggestive in this direction. They immersed the omentum of the decerebrate cat in a suspension of finely divided carbon, and within a short time were able to detect carbon particles free both in the capillaries of the liver and upon the phagocytic endothelial cells which line them. These particles could not have reached the liver except through the blood stream. By some process, the nature of which is not known, carbon particles pass into the blood capillaries of the omentum and drift up to be arrested in the capillaries of the liver. The situation within the lung alveoli is possibly similar, particles within them being very close to the blood stream and quite as well able to get into these capillaries, as in the case of particles which enter the omental circulation.

If now we review these three methods of removal, it is apparent that phagocytosis plays an exceedingly important, indeed an indispensable part in the process.

## II. The Alveolar Phagocytes

Mavrogordato describes the phagocytosis of carbon in the lung of the guinea-pig in the following summary:

(i) The dust cells, mostly cells derived from pulmonary epithelium, take up coal dust with great avidity and are very readily shed. Dust is seen in fixed cells as well as in free cells, but the former are for the most part isolated, and one does not meet islets of dust-loaded cells to any extent.

In the text leading up to this summary he makes such statements as: "Many cells—of large and small endothelial type and dust laden—were to be made out free in the alveoli, but there was also much dust in the fixed cells." And later, in describing experiments with the Transvaal silicious dust, he again speaks of cells of "endothelial type." One cannot decide whether Mavrogordato recognizes the possibility of phagocytosis by actual endothelial cells or uses the term to describe the appearance of cells of epithelial origin. This view, that the alveolar epithelium is responsible, is in agreement with that of many investigators, but it is not confirmed by recent observations; and since the origin and original position of lung phagocytes is of considerable practical importance it is necessary to review the data which have been presented..

The idea that the large flat cells, seen to contain dust in properly exposed animals and persons, are derived from the epithelium is singularly easy to hold. By ordinary methods of staining practically all the cells containing particles, which are found either inside, clinging to the alveolar walls, or within adjacent lung tissue, are indistinguishable from lining epithelial cells. Knauff (6) presented this view many years ago. Ruppert (7), Schottelius (8), Wainwright and Nichols (9), Briscoe (10) and Sewell (11) agree with him. Arnold (12), Oliver (13), Beitzke (14), Watkins-Pitchford (15), and Willis (16) believe that a variety of cells may be responsible. Haythorn (17) and Klotz (18) were the first to hold substantially that the endothelial leukocyte is of importance. Such cells must be derived from the lining of blood capillaries of lymphatics or from the circulating blood. They are, therefore, out of contact with dust as it reaches the alveoli. A definite migration through the lung tissue into the alveolar spaces is necessary in order to bring them into action. Haythorn's identification of the lung phagocytic cells as endothelial depended upon the facts that they were identical in size and appearance with endothelial leukocytes, that they were phagocytic for blood pigment, carbon, and all kinds of cellular debris, and were apparently the same type of cells as were found in tubercles. Gardner (19) studied nearly one hundred dusted guinea-pigs, and during the stage of phagocyte formation failed to find a single mitotic figure within alveolar epithelium. He says:

. . . Moreover, no trace of dust has been found *within* an attached alveolar epithelial cell. One of Miller's great contributions to our understanding of pulmonary anatomy has been the distention method of fixation. By its use it is possible to determine with a considerable degree of accuracy the relation of one structure or cell to another. If a collapsed or undistended lung be examined, it seems indisputable that dust particles are lying within attached epithelial cells. If, however, the lung be fixed by the distention method, the dust cells, although they may be near the wall, will always be superimposed upon the epithelium or lying at a little distance from the wall. It would seem that the employment of this technical procedure has enabled us to eliminate one of the proposed sources of the intra-alveolar phagocyte.

No definite conclusions on this disputed question are possible at this time. The evidence would seem to have reduced the question of the origin of the alveolar phagocyte to a consideration of the local vascular endothelium in the lung and to studies on the transitional cell of the circulating blood.

Neither Haythorn, Klotz, nor Gardner, however, employed staining reactions

which identify endothelial phagocytes. Their conclusions depend upon analogies, or upon attempts to eliminate the alveolar epithelium from consideration. Slavjansky (20) practically accomplished the identification of endothelial cells as the important agents in 1869. He gave intratracheal injections of indigo followed by intravenous injections of cinnabar, and shortly after he found phagocytic cells, containing cinnabar particles and indigo. free in the alveoli. He considered that these cells were mononuclear elements derived from the circulating blood. Tchistovitch (21) used a somewhat similar technic in 1889. Recently Sewell (11) attempted the same sort of experiment but, for technical reasons which need not be outlined, failed in the proper execution of his task.

Foot (22) and Permar (3)—the latter in a very beautiful and conclusive series of observations—have carried through the same type of experiment and leave little doubt as to the final conclusion. The technic used by Permar depends upon the following facts. It has been known for some time that the endothelial leukocyte will take up certain vital stains. Thus, if rabbits or guineapigs receive intravenous injections of trypan blue, isamine blue and a number of other dyes, it is found that after a few days certain large cells in the liver, spleen, lymph nodes, and bone marrow are filled with the dye. In the normal animal practically no stained cells are found in the lung. The uninjured endothelium of the blood capillaries and lymphatics does not take up the dye. It has, however, been shown that injured or irritated vascular endothelium very readily becomes phagocytic (23). If, now, the animals are injected intravenously with isamine blue and intratracheally with finely ground carmine, the injections being repeated for several days, one is soon able to find numerous blue-stained endothelial phagocytes in the lung, and these clearly identified cells may then be followed in relation to the phagocytosis of the intra-alveolar carmine.

On examining animals so treated Permar never found the epithelial cells of the alveolar lining either vitally stained or carmine containing. He discovered that the number of blue-stained cells in the lung increased with intratracheal carmine injections and sums up his work as follows:

> . . . The large mononuclear phagocyte of the lung is derived by proliferation from the vascular endothelium, and in large part that of the capillary network in the walls of the air sacs. This proliferative activity is accomplished by mitosis. The point of origin in the pulmonary capillaries is indifferent and determined only by the proximity of an irritant in the lung tissue. The proliferating cell is endowed with an ameboid motion, and once free, migrates directly to the site of the irritant, in the air sacs and bronchial tree. The point of entrance of the wandering cell into the alveoli is equally indifferent, the cell passing directly between the epithelial plaques to gain the free air space where it at once proceeds to collect within its cytoplasm the foreign substance which has called it forth. Ordinary pulmonary anthracosis, now accepted as almost a physiological process, illustrates how slight an irritant may give rise to a proliferative endothelial reaction.

If we return to Haldane's paper we find the following paragraph:

> It is highly probable that insoluble dust particles are attractive and stimulating to dust-collecting cells in proportion to the soluble substances absorbed in the dust particles; and that the particles containing little of these substances will be correspondingly unstimulating. This, at least, seems to me the most probable explanation of why some kinds of insoluble dust stimulate the cells and others do not; and the facts so far known

seem to be consonant with this explanation, though far more work on the whole subject is required.

Haldane then seems to explain the difference between the effects of insoluble carbon dust, which is harmless, and the most dangerous sort of insoluble silicious dust, by the suggestion that the carbon particle, which has to a high degree the power of adsorbing material upon its surface, upon reaching the alveolus becomes coated with material which renders it not only highly irritating so that many phagocytes at once begin to concentrate upon the scene but also highly desirable for phagocytosis. Silica, which is notably non-adsorptive, owes its tendency to remain in the lungs and to resist elimination to the fact that absence of adsorbed material renders it less irritant and less readily phagocytized. In another paragraph, however, he makes the statement that all the different sorts of dust used by Mavrogordato were apparently taken up by phagocytic cells with the same degree of readiness, and the difference between them lies in the fact that cells which have ingested carbon are able to move steadily out of the lung, whereas the reverse is true with silica. In Mavrogordato's words:

> 1. Coal and shale are taken up by cells which are quickly shed, and consequently do not set up processes which block lymphatics. These cells frequently break down, and masses of dust are to be seen on the surface of the alveolar walls.
>
> Flue dust and crystalline silica are taken up by cells which tend to remain *in situ* and form plaques, which appear early and persist. They are the only site of fibrosis made out in this investigation.
>
> Dusts which form plaques are not readily eliminated.

Mavrogordato apparently believed that carbon particles reaching an alveolus stimulated the alveolar epithelium near by to proliferate and to ingest them. Permar, however, has shown that the particle must arouse proliferation in the capillary endothelium with subsequent detachment of cells and migration through the wall into the alveolus. While it is true that such cells have their origin very close to the air space, the actual process involved is somewhat more formidable than that conceived by Mavrogordato, and gives better play for differences in physical characteristics of foreign particles.

On considering this entire situation it seemed wise to attempt an analysis of all the possibilities raised by Haldane and Mavrogordato, keeping in mind their fundamental contention that rate of dust elimination is as important as rate of inhalation, and subjecting the different phases of the process to experimental procedures. One step in this work has been accomplished. It was first desired to find out whether all dusts really were taken up by phagocytic cells with equal degrees of readiness. Fenn (24) has prepared suspensions of carbon and quartz and has shown that the polymorphonuclear leukocytes of the rat ingest carbon four times as readily as quartz. He has recently extended this observation to phagocytes obtained by scraping the surface of the lung—the method employed by Briscoe for obtaining similar material—and thus has shown that in the very first step of the process of removal of foreign material silica lags behind carbon.

## III. The Disposal of Foreign Material

In the last section the lung phagocytes have been identified, and the character of the discussion has made it evident that phagocytosis is an extremely important early step in ridding the al-

veoli of foreign material. In early observations upon lung fibrosis investigators (25) advanced the view that particles might pass between the alveolar epithelial cells or actually pierce them to reach the lung tissue. These ideas are apparently entirely discounted today. Though there may be differences of opinion as to the cell responsible, there is unanimity that particles leaving the alveoli must first be ingested by phagocytes.

The questions which next arise relate to the length of time required by phagocytes to collect a load of foreign material and their subsequent movements. Haythorn (17) gave soot inhalations to rabbits for eighty-seven days and found pigment-bearing cells, "only in the alveoli and interalveolar spaces and there was no evidence that any had migrated as far as the large lymphatics. All these points seem to indicate that the phagocytic cells are not transient scavengers, but in a more leisurely manner gather their pigment-load and transport it to the tissue spaces." Willis (16) also feels that the "*absorption* [of alveolar phagocytes] must be relatively slow, since in these normal animals [caged guinea-pigs in the laboratory unsubjected to dust inhalations] increments of dust are taken into the lung only very slowly and gradually, yet the dust cells are always seen."

Permar (3), using powdered carmine by intratracheal injection, showed that this material begins to be taken up at once by the few endothelial phagocytes in the alveoli at the time of injection and that, while all the material introduced had not become intracellular in five hours, by the end of twenty-four hours even if the injections were large all the foreign particles were intracellular. He says:

> . . . These cells take on the most extraordinarily heavy loads of pigment, even when the particles are relatively coarse.* As a result, they increase enormously in size, and the nucleus becomes completely masked by the quantities of granules with which the cytoplasm is packed.

This author verifies the observations of Haythorn and Willis on the slowness with which cells which have taken up dust leave the alveoli. He states:

> Though the foreign pigment is entirely intracellular at the end of a twenty-four hour period, the endothelial phagocytes do not leave the alveolus at a rapid rate. On the contrary, there is often very little difference in the picture, even at the end of five or six days. In four animals killed after this interval, the alveoli still seem equally crowded by the same groups of large, heavily loaded cells. This is borne out by the relatively slight change in the number of cells found migrating along the lymphatics after six days as compared with that found after twenty-four hours. In fact, in some animals there seems to be a slowing down after the first acute reaction, and the migrating cells are even fewer in three to five days than after twenty-four hours, indicating a lessened activity after the acuteness of reaction is gone. The actual time period required to effect complete clearing of the alveoli could only be estimated by experiments covering long periods of time, possibly even running into months.

It should be pointed out that the observations so far quoted, Haythorn, Willis, and Permar, have been made (1) by the use of carbon dust, (2) upon ani-

*Fenn (24) has shown that *in vitro* carbon particles 4.7 μ in diameter are ingested as readily as 3.2 μ particles. It has been held rather generally, apparently as a result of findings in South Africa (26), that only very small particles are responsible for damage to the lung. The great majority of silicious particles recovered from the lung postmortem were found to have a diameter less than 1 μ. Particles as large as 12 μ were found in the lung but were very few. The question as to the size of particles which may actually reach the alveoli has never been investigated from a careful quantitative point of view. If large particles do reach the alveoli there is no apparent reason why they should not be picked up by phagocytes and carried into the lung tissue.

mals acquiring a normal degree of lung pigmentation while living under laboratory surroundings, and (3) upon animals receiving intratracheal injections of carmine suspension. The results are in agreement but this does not assure us that flint dust, organic dusts, etc., will bring about similar states of affairs.

Many investigators have reported that dust falling upon the ciliated epithelium of the bronchioles begins to move toward the mouth at once, and after a single moderate dusting these upper passages may become quite clean before material begins to leave the alveoli either in cells which pass through the wall or which move up on to the ciliated surface and are then carried away.

Permar has found, and others are in agreement with him, that phagocytes containing dust tend to accumulate near the alveolar entrance and apparently move through the wall in this neighborhood to enter the terminal lymphatics of the lung which arise about the alveolar ducts. After reaching a lymphatic the dust-carrying phagocyte, partly through its own ameboid activity and partly through the lymph flow, moves toward the lymph nodes at the root of the lung. Twenty-four hours have been found necessary for the traverse of this distance in the case of carmine by Permar, and twenty hours for manganese dioxide by workers in our own laboratory. Whether this rate of travel is reduced after foreign material begins to accumulate, is not known. Permar records a decreased rate of migration from the alveoli five or six days after intratracheal injection of carmine. Since the lymphatics of the lung are found about the blood vessels and bronchi, it is natural to see cells containing pigment, and foci of cellular debris and pigment at such points. Willis has commented upon the fact that in the young guinea-pig there is practically no lymphoid tissue in the lung, but as life goes on lymphoid accumulations begin to appear. These masses are prominent along bronchi and blood vessels, and Willis presents a very beautiful reconstruction of one such fusiform collection about a small artery and comments upon the fact that "Irvine and Watt (27) described an irregular periarterial thickening as one of the early lesions in pneumokoniosis and remarked that the thickenings are not 'nodular' formations."

While dust may naturally be found scattered long the lymph passages from their origin to the peribronchial nodes, a good deal is usually seen in such lymphoid collections, and as they continue to enlarge in the face of steady dusting a definite mottling of the lung is produced and areas of lymphoid proliferation begin to be found immediately outside alveoli at the very beginning of lymph channels. Fibrosis apparently takes place in close relation to the lymphatics and to such collections of lymphoid tissue, and it seems probable that both increases in lymphoid collections, through which lymph must flow to reach the root of the lung, and connective tissue encroachment upon lymph channels must combine to slow lymph drainage and to arrest more and more dust-laden phagocytes before they reach their final destination in the lymph nodes at the lung root. It should, however, be remembered that while a certain amount of data exists as to lymph movement out of the peritoneal cavity and out of the limbs, there is no direct knowledge upon the rate of lymph flow in the lungs and upon the factors which bring it about.

Mavrogordato has contended that alveolar phagocytes may wander out of lymphatics and through the walls of large bronchi. His data on this point are

insufficient and are unconfirmed by other observers. The reader will recollect that he distinguished between carbon and silica by the fact that cells containing carbon were eliminated more readily than those containing silica. The cells containing carbon he believes to be quickly shed, apparently chiefly by moving up onto the ciliated epithelium. Silica-containing cells, on the other hand, do not tend to move but are apt to aggregate and form plaques which become foci for fibrosis. Mavrogordato believes that the rate of silica removal can be increased by adding carbon to the air breathed, thus inducing a more vigorous reaction and getting rid of some of the silica as a result of the intense drive at the carbon. He implies that where air has contained silica but workmen have experienced no harm there has been an admixture of carbon or of some dust with similar properties which has kept the silica on the move. Haldane goes so far as to suggest that such mixtures be made artificially in work which demands inhalation of silicious dust.

These are contentions which are not verified experimentally, and, as has been pointed out, the ground upon which they rest seems frequently to be insecure. They are peculiarly susceptible to experimental attack and should either gain our confidence or be cast aside in a few years' time.

## IV Some Final Aspects of the Problem

Collis (28), in his classical lectures upon the pneumokonioses, calls attention to the innocuous character of coal dust, of limestone and plaster of Paris, and speaks especially of crystalline silica as being the principal source of real lung damage. He calls attention to the fact that in the amorphous form this substance is not known to do harm, and that silicates such as clay (aluminum silicate) are also harmless. He remarks:

> Silica dust, then, possesses certain qualities:—(1) physical, (a) such smallness as permits the particles to be carried into the alveoli, and (b) such hardness and angularity as suggest that the particles can act as centres of irritation; and (2) chemical, (a) acidity which, owing to the presence of the element silicon, may render the particles capable of entering into and modifying the colloidal structure of protoplasm, and (b) smell, possibly due to a vapour, as yet undetermined, given off when silica is fractured.

We do not know which or whether any of these properties is responsible for the harm done by silica. To them Haldane has added another, the non-adsorptive power of silica. We call attention to these statements only in order to show how little fundamental exploration of the field there has been. With the exception of Fenn's observations, which deal with carbon and silica alone, we have no data on differences in rate of phagocytic intake, and with the exception of Mavrogordato's somewhat unsupported contentions, no data upon different rates of movement of different dusts which reach the alveoli. While silicious dust is the most deadly, even carbon dust produces some lung damage, and the whole question as to whether pure organic dusts can do significant harm may be regarded as unsettled. Fortunately, the field is one which can be explored through animal experimentation, and it is probable that a period of more exact quantitative investigation is at hand.

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# INVESTIGATIVE OPPORTUNITIES IN THE PHYSICAL EXAMINATION OF LARGE GROUPS OF INDIVIDUALS*

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THE physical examination is, or should be, the foundation upon which any plan for supervision of health is constructed. It is, of course, entirely possible to accomplish something without physical examination, but positive results depend upon the amount of real information obtained concerning the individuals whose health is supervised. The old comparison of the examination of personnel with the examination of property, inanimate machinery and product still holds true.

In many ways the actual results of physical examinations in industry have been disappointing. These examinations have demanded the expenditure of time, energy and money. Occasionally they have been remarkably useful and have led to the detection of cases of disease in early and perhaps curable stages. Moreover, they have made it possible to arrange employment better suited to the capability of the worker. In addition, much valuable individual advice has, of course, been given, which has resulted in improvement in the physical condition of the individual workers. Nevertheless, the results of physical examinations do not seem at present to be stated in terms that enable us to appraise the personnel as exactly as the material assets of the industry can be appraised.

There are several reasons for this. In the first place there are no generally accepted standards of health. The Great War demonstrated how standards for acceptance into military service may vary. As has often been said, medical men have mainly studied disease, and usually manifest disease, and are not accustomed to studying health. There are now slowly accumulating data for health standards but this collection of material is of very recent origin. In general our instruments of examination are tested on the sick, and only subsequently do we get the necessary normal controls which are essential to the establishment of health standards. A perhaps familiar illustration is the occurrence of albuminuria in young men. That albumin is occasionally present without significance in the urine of young men has long been known, but it seemed to be agreed that this finding was not compatible with any reasonable standard of health. In the course of the examination of Harvard students, albuminuria is found in about 5 per cent. of the men, the percentage being rather higher in the younger students and rather lower in the older students. In 1920 we found albumin in 7.3 per cent. of approximately 600 freshmen, with an average age of 18. In a group of 400 upper classmen, with an average age of 20, examined at the same time, it was present in only 2.2 per cent., and in a group of 400 students in one of the graduate schools, it was present in less than 2 per cent. Furthermore, on reexamination this percentage is fixed, but

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the individuals vary somewhat. Those who habitually present albuminuria during the day but not at night seem to belong to a particular type. In the cases in which albumin was present in the urine, all of the requisite examinations were, of course, made to prove the presence or absence of a nephritis. In the age group in which we are concerned, nephritis is actually present in less than 1 per cent. of the cases in which albuminuria is found. Inasmuch as albuminuria can be induced in a large percentage of persons by violent exertion, is it necessary to assume that the albuminuria associated with the usual mild exertion of daily life is abnormal? At Harvard University we are continuing our studies on albuminuria in the hope of creating some sort of fairly definite standard of health in respect to this particular condition.

The introduction of the stethoscope has not been an unmixed blessing. Many physicians have acted on the thesis that a heart with a murmur was a damaged heart. At Harvard University Dr. Parmenter has recently studied cardiac murmurs, and has found that approximately 2 per cent. of the students have murmurs and other signs which may safely be accepted as indicating a damaged heart. These figures are essentially the same in similar series in schools and industries, which exclude individuals in the degenerative period of life. On the other hand, in over 70 per cent. of the students a cardiac murmur of considerable intensity, concerning the existence of which there would be no dispute among auditors, can be demonstrated under the appropriate conditions of breathing and posture. With forced expiration without breathing and in the recumbent position, a systolic murmur can usually be heard at the pulmonic area. Such findings certainly suggest that the presence of a systolic murmur is compatible with a reasonable health standard.

I might continue by taking up each item in the physical examination and might point out the necessity for the establishment of a satisfactory standard in each item. There are problems and opportunities for investigation which begin with the first estimations we usually make, namely, the height and weight. The investigative opportunities certainly include the estimation of the blood pressure in which there is increasing evidence that the normal standard for a single observation must be given wide limits which may, however, be progressively restricted with increasing observations.

The physical examination, however, should do very much more than establish the presence or absence of organic disease, although this is, to be sure, the necessary first step toward the utilization of the physical examination in industry. The inadequacy of the usual type of physical examination to answer the question as to whether a given individual is fitted for any particular task has led to the development of so-called physical efficiency tests. The literature is full of physical efficiency tests which vary from a simple strength test to a rather complicated record of achievements under the reproduced specialized conditions of the industry for which the person examined is a candidate. As an illustration of the latter, we have the efficiency test which was developed for aviators. In general, efficiency tests have the same weakness which has been commented upon in the organic examination, namely, the lack of accepted standards. It usually happens that the individual examiner becomes quite expert in observation and interpretation, and he finds the particular test which he

applies extremely valuable, but the tests do not often lend themselves to general use, and when they are put into general use the results are very divergent.

It seemed to us at Harvard University that it ought to be possible to discover by appropriate examinations some acceptable classification of the functional capacity of the different physiological systems. We began with what we termed the mechanical use of the body, and this we studied under two main headings, namely, how the individual stands, and how he uses his feet. We undertook an arbitrary classification into four groups —a classification which has now been in use since 1919, and which has given very satisfactory results. For example, we have classified as group D, which is our lowest and poorest classification of bodily mechanics, from 25 to 35 per cent. of the students. This system of classification enables us at once to visualize, as a group, individuals with marked round shoulders, lordosis, etc.

In 1919, our figures in regard to bodily mechanics, merely on the basis of posture, not on the basis of feet, were: group A = 7.5 per cent.; group B = 12.5 per cent.; group C = 55 per cent.; and group D = 25 per cent. This examination was confined entirely to freshmen. In 1921 the examination of 773 freshmen showed the following results: The percentage of men in the A group was 1.03; in the B group, 22.5; in the C group, 47.7; and in the D group, 25.7. In these last figures the criterion of bodily mechanics was enlarged to include the use of the feet. In the graduate schools 282 students were examined, of which number 0.77 per cent. were in the A group, 15.5 per cent. in the B group, 51.1 per cent. in the C group, and 30.2 per cent. in the D group. This suggests very much that the percentage of people who have a poor mechanical use of the body (and groups C and D represent poor use) is about the same in the older group as it is in the younger group. One sees at once the difference between the results in this particular method of examination and the findings in regard to albuminuria, inasmuch as albumin tends to disappear with age. There is a certain amount of evidence that poor mechanical use of the body tends to increase in later life and is the presumable cause of a certain amount of backache, etc., and the possible cause of various other disturbances. It is, therefore, incumbent upon us to attempt some means to improve this condition. By the use of this simple classification it has been possible to insist on the importance of recreative exercise in the students with poor mechanical use of the body, and to give them rather definite instructions and the necessary encouragement to improve their bodily mechanics. It is our experience that associated with this improvement is usually an improvement in general physical well-being. It has furthermore been of considerable interest to check up the association of general defects with this poor form of bodily mechanics. For example, we have found that with very few exceptions those individuals who have albuminuria persistently during the day, but who have none immediately after the recumbent period at night, are classified as group D in regard to posture. We have also found that those students who deviate from the average standards in pulse rate and blood pressure readings also tend to fall in this particular group.

In a similar manner, Dr. Stanley Cobb undertook a survey of the students from the point of view of what we finally designated as nervous stability. Dr. Cobb's paper in this issue of the JOURNAL presents the results of his study.

His study, while inconclusive, should, nevertheless, be stimulating to further work, because nervous instability bears a very definite relation to industrial inefficiency, just as it does to academic inefficiency in college life. If it were possible to classify men on the basis of nervous stability, it would be possible to make a much more intelligent selection of men for particular positions, and furthermore it would give the foundation for constructive advice toward the remedy of this condition in its early stages.

It is not always possible to separate exactly the physiological systems because, as is well known, these physiological systems are interdependent, and are all subject to nervous control. It is, indeed, probable that most of the symptoms referable to the cardiovascular system, when not of organic origin, are traceable to functional disturbances in the nervous system. The war gave us a considerable amount of data concerning a condition known as "effort syndrome"—a condition which we know now is very common in civil life. It apparently has no organic basis and is to be explained on the basis of functional disturbance of the central nervous system. In the University we are constantly brought face to face with this condition of effort syndrome, usually under the guise of so-called athletic heart. Consequently, the importance of the establishment of a proper standard in the examination of the heart is here peculiarly manifest. Numerous illustrations could be given in which a diagnosis of heart disease has been made, based on cardiac irregularity and the presence of murmurs and of certain symptoms related to the cardiovascular system, such as becoming easily winded on slight exertion. Such individuals may, in the course of time, appear again for examination for athletic competition and may or may not present the same objective findings, and very frequently present none of the subjective symptoms. The lapse of time usually has sufficed to suppress such a symptom as breathlessness on slight exertion. It is of considerable interest that the factors which seem to operate best in the interval of time which has lapsed are those factors which tend to stabilize the nervous system. While there can be no doubt that graded exercises are of great value, particularly in marked cases of effort syndrome, nevertheless very often an individual who was unable to undergo athletic competition one year may easily undergo athletic competition the following year, although he may have taken very little in the way of actual physical exercise.

I trust that I have made it clear that the physical examinations should be much more than a purely objective scrutiny of the bodily organs. The obvious and apparent organic defects will be relatively few in any industry. The value of the physical examination will depend upon the wider application of the examination to the actual functional capacity of the individual. In that particular field only very feeble beginnings have been made and the collection of data is for the future. While it is, of course, true that the situation in a university is different from the situation in an industry, nevertheless, there are many important features in common. There are two possible advantages on the side of health supervision in industry, namely, that the industrial workers are a step ahead of the university students in the progress toward their more or less fixed vocation in life, and that in industries one is dealing with actual conditions of life, whereas in the university one is dealing with the temporary and entirely preparatory conditions of life. Further-

more, in industry there are to be solved many special problems particularly related to the development of fatigue and the effect of fatigue upon the human system.

In industry, the constructive side of health supervision must be based upon carefully acquired data. The constructive efforts which result in better physical condition, better bodily functioning of the individuals concerned will inevitably result in an increased efficiency in the industry itself. But before there are adopted extensive programs for the systematic improvement of the physical conditions of the workers in industry, it is necessary that further progress should be made on the solution of some of the problems of physical examination itself.

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# A REPORT ON THE BRIEF NEUROPSYCHIATRIC EXAMINATION OF 1,141 STUDENTS*

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In 1914 physical examination of students was taken up at Harvard University. Dr. Roger I. Lee, Professor of Hygiene, has reported the method of examination and some of the results elsewhere (1) (2) (3). In 1916 an orthopedic examination of each man was also made under the supervision of Dr. Lloyd T. Brown and an interesting paper which bears important relation to this report has been published (4). Following this policy of taking up new fields of special examination as the need arises, Dr. Lee asked me, in the autumn of 1920, to plan a brief neuropsychiatric examination which might be added to the routine physical and orthopedic examinations. This seemed necessary to him because such a large number of the students showed symptoms of that vague but incapacitating malady known as "nervous instability."

## Method of Examination

In order to avoid the diffuseness likely to occur in examination for such an ill-defined entity, we decided to investigate four main questions:

1. What is the incidence of neurotic history in the group?
2. Can any physical sign be taken as an indication of nervous instability, or as indicating that the individual is potentially unstable?
3. Is endocrinopathy common, and what is its relationship to nervous instability?
4. After four years of observation do the men who showed certain symptoms at their first examination tend to fall into significant performance groups?

The last question, which is probably the most interesting, cannot be answered in this report. Here we can only hope to discuss the correlation between physical examination and past history.

The routine examination (see Figure 1) contains many neurological and psychiatric features, such as questioning concerning history of syphilis, habits, and sleep, and examination of pupils, thyroid, heart rate and rhythm, blood pressure variation with posture and knee jerks. It was decided, therefore, to add to the examination card a list of questions which might bring out any history of previous neurosis, and a group of physical observations (Figure 2) which would bear directly on abnormalities of the nervous system, especially the vegetative nervous system, which is known to be affected in neurotic and psychotic conditions.

The examination itself was carried out by a group of eight physicians who, besides being familiar with the routine examination, had discussed with Dr. Brown and me what was desired in each special question. Knee jerks, for example, had to be roughly standardized into absent, sluggish, active, and exaggerated, which terms were designated on the examining cards by the signs —, +,

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Figure 1

## HARVARD UNIVERSITY

### DEPARTMENT OF HYGIENE

Full name of student..
Class Age Date of examination.

### FAMILY HISTORY

F., born in
M., born in

### PAST HISTORY

Underline and give approximate age at which subject had any of the diseases listed in the square:

What injuries?
What operations?
Present general health ..Appetite Sleep. hrs.
Have done . ; also
Am doing outside remunerative work hrs. per week
Usual recreation previously " " "
" " now " " "
Dates of successful vaccinations. Failures
Typhoid vaccination
Cups tea average. per Cigarettes average per
Cups coffee " " Pipes " "
Swimming Cigars " "
Color-vision =

Measles
Pertussis
Mumps
Chicken-pox
Scarlet Fever
Typhoid Fever
Diphtheria
Malaria
Smallpox
Pneumonia
Pleurisy
Rheumatism
Tonsillitis
Influenza
Otitis Media
Gonorrhea
Syphilis
Constipation
Chorea
Convulsions

### PHYSICAL EXAMINATION

Color Apparent Age Peculiarities
*Eyes:* Right. Left Corrected to Right Left
Wears glasses, constantly, reading, distance, when obtained. Needs to see oculist.
*Hearing:* good, fair, poor. Needs aurist
*Gen. Devl.:* excel., av., poor. *Wt.:* thin, av., obese. *Skin:*
Skeletal Type
Distribution of fat and hair
*Chest:* cir. at xiphoid { Exp. in. / Neu. in. / Ins. in.
*Scars*
*Acne:* Face. . Chest . Back
*Weight:* lbs. *Height:* *Pup.:* R. L. re. to L. and A. St. Dance.
*Teeth:* good, av., poor, neglected, false.
*Shoulders:* norm., round. *Scapula:* norm., scaphoid. *Thyroid:* norm., sl. enlarged. *Vac.:* R. L. arm, leg, doubtful, irreg., good.
*Chest:* norm., flat, funnel, pigeon, flaring at base.
*Heart:* rate Regular, irreg., interm., $A_2$ $P_2$.
From med. line { Left nipple cm / L. bord. card. dul. (5th sp.) cm / R. bord. card. dul. (4th sp.) cm. / Ap. imp. Seen. felt cm
Murmurs
*Lungs:*
B. P. standing. S mm. D mm. recumbent. S mm. D mm.
*Blood:* Hb. % (Tallquist)
*Abdomen:* norm. Hernias: ing., fem., umb., epig. *Liver:* edge felt. *Spleen:* felt.
*R. Kid.:* felt. *L. Kid.:* felt.
*Penis:* norm., circum. *Testes:* R. L. Abnormality *Varicocele:* R. L.
*Lymph N.:* C. Ax. Epitr. Ing.
*Knee J.:* R. L. *Vert. Col.:* norm. Lordosis: Scoliosis.
dors. lumb.
*Feet:* { History / Tender Points Shoes / Use
Long arches: R. high, low, flat. L. high, low, flat. Ant. Arches: R. present, absent. L. present, absent.
*Nose:* obstruction R. L. nostril Chr. Pharyn.
*Tonsils:* 1, 2, 3, 4 Removed totally, partially
*Urine:* Sp. G. = Alb. = Sug. = Sed. =

++, +++. Dermographia was tested for by sharply stroking the skin of the abdomen and chest with the pulp of the fore-finger, the appearance of a conspicuous red line being considered as "positive." Skeletal types or unusual developments were described best by adjectives such as slightly acromegalic, eunuchoid, feminine, etc., which, taken with a description of the distribution of the fat and hair, and notes on any unusual genital development, were intended to give an index of the endocrine balance of the subject.

FIGURE 2

Nervous symptoms
Convulsions
Chorea
Bed-wetting
Night terrors
Sleep-walking
Stammering
Development of size and weight and onset of puberty    Shaving    Voice
Any nervous symptoms at present
Adaptability    Mood
Muscle tone
Tremor
Vasomotor, dermatographia, flushing, blushing sweating, palpitation, sinus arrhythmia and blood pressure variation
Skeletal (type and development)
Distribution of fat and hair
Shape of external genitalia and their development

The questions for the determination of past history were somewhat standardized; thus, in asking about "mood and adaptability" the examiner would say: "Are you a good mixer? Lonely or sociable? How do you get along with people?" and "How are your spirits? Ever melancholy or especially elated?" The early development and onset of puberty was determined roughly by asking whether the student had ever had any period of being a "fat boy" or growing extraordinarily fast, and asking for the date of the first "wet dream" or emission, of the voice change, and the beginning of shaving. At first I examined many of the men myself, and worked with each examiner until it seemed that he understood what was desired. The latter part of the examining was carried on with less supervision.

## RESULTS OF EXAMINATIONS

At the end of the examinations the results were tabulated in various ways and the tables analyzed for significant data as follows:

The incidence of neurotic history in the 1,141 men examined was 188—*i. e.*, 6.4 per cent. gave a history of one or more of these troubles:

| | No. | Per Cent of 188 | Per Cent of 1141 |
|---|---|---|---|
| Abnormal mood or difficult adaptation ...... | 14 | 7 | 1 |
| Nervous symptoms in past ............... | 2 | 1 | 0.17 |
| Convulsions .......... | 5 | 3 | 0.43 |
| Chorea ............... | 4 | 2 | 0.35 |
| Bed wetting ........... | 22 | 12 | 2 |
| Night terrors ......... | 26 | 14 | 2 |
| Sleep-walking ......... | 37 | 20 | 3 |
| Stammering (34 still stammer) .......... | 44 | 23 | 4 |
| Severe nervous breakdown ............... | 2 | 1 | 0.17 |
| Nervous symptoms at present ............. | 78 | 41 | 7 |

Taking up the findings at the physical examination in relation to the histories obtained, we see that (Table 1) the men with neurotic histories differed physically from those with no such history only in more frequently showing exaggerated knee jerks and rapid heart beat and other vasomotor phenomena, such as dermographia, flushing, excessive sweating and palpitation, but these symptoms were found in the men with neurotic histories only 6 to 10 per cent. more frequently.

The presence of tremor, dilated pupils, acne, or variations in blood pressure with change of position did not seem to be significant in this connection—*i. e.*, these symptoms occurred just as frequently in the men with no history of nervous instability as in those with such a history. Only by following up these individuals with neurotic histories for years can we determine whether they are more *liable* to *future* breakdown than are the other men.

TABLE 1.—PHYSICAL FINDINGS IN RELATION TO HISTORY OBTAINED

| Group | Tachycardia | Blood Pressure Variation | Other Vasomotor Phenomena | Dilated Pupils | Tremor | Exaggerated Knee Jerks | Acne | Neurotic History |
|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % |
| All the men examined (1,141) | 25 | 14 | 19 | 10 | 7 | 10 | 26 | 16 |
| No neurotic history (953) | 23 | 14 | 18 | 9 | 7 | 9 | 27 | 0 |
| Neurotic history (188) | 33 | 14 | 25 | 11 | 7 | 16 | 25 | 100 |
| Endocrinopathy (22) | 18 | 9 | 36 | 22 | 4 | 9 | 4 | 13 |
| Albuminuria (44) | 36 | 11 | 25 | 11 | 4 | 14 | 34 | 23 |

*Tachycardia* indicates the men whose pulse rate was 100 or over during examination.

*Blood Pressure Variation* indicates that the difference between the systolic pressures standing and recumbent was more than 15 mm. Hg.

*Other Vasomotor Phenomena* indicates that there was excessive flushing, sweating, dermographia, attacks of palpitation or sinus arrhythmia.

*Dilated Pupils* indicates a diameter of 6 mm. or more.

*Tremor* indicates tremor of extended fingers.

*Exaggerated Knee Jerks* indicates that the knee flies out on a slight patellar tap.

*Acne* indicates conspicuous lesions on face or trunk.

*Neurotic History* indicates past history or present complaint of nervous disorder.

Since vasomotor disturbance seemed in some ways related to neurosis, other special symptoms of this category were analyzed—*e. g.*, of 285 men having tachycardia, 20 per cent. had systolic blood pressure variation of over 15 mm. Hg on changing position, and 9 per cent. had dermographia, whereas of the whole group only 14 per cent. showed unusual blood pressure variation, and 5 per cent. dermographia.

Again, of the 161 men having a blood pressure variation of over 15 mm. Hg as above mentioned, 9 per cent. also had dermographia. Of forty-four freshmen who showed albuminuria, 14 per cent. showed exaggerated knee jerks, 22 per cent. a neurotic history, 36 per cent. tachycardia, and 25 per cent. other vasomotor phenomena. Also, of twelve unclassified and Business School men who had albuminuria, 42 per cent. showed tachycardia.

In other words, it is more common to find tachycardia, sweating, flushing and exaggerated knee jerks among men who may be considered neurotic because of either their present complaints or their past histories, than among more stable individuals, but this increase only amounts to approximately 8 or 10 per cent.

Throughout the examinations a careful watch was kept for individuals who might be considered endocrinopathic, but out of the total group only twenty-two were discovered. They were classified as:

A. Precocious development (6)
B. Delayed development (8)
C. Abnormal development (8)

Of the men classed under "Abnormal development" only two showed conspicuous symptoms, and they were both of the *typus femininis.* There were two other less marked individuals of this type, and two others that suggested hypothyroidism. The remaining two ap-

proached the acromegalic type, but not one of the whole group of eight would have considered himself abnormal.

This number is too small to analyze further or to draw conclusions from, but it is interesting to note that as a group (Table 1) these men showed less neurotic history and acne, and more vasomotor disturbance and dilated pupils than the average. It is also of interest that sinus arrhythmia was not found at all in the delayed development class. Minor symptoms that might be considered due to "endocrine imbalance" were taken into consideration.

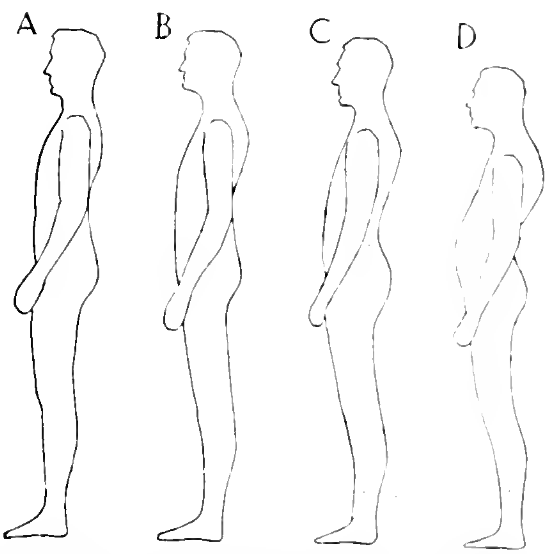


Fig. 3.—Diagram showing standard classes A, B, C, and D, according to bodily mechanics or posture.

Perhaps the most interesting correlation obtained was from a tabulation of the nervous symptoms in relation to "bodily mechanics." Dr. Lloyd Brown (4) has described how the posture of each man is examined and classified, A men being normal, B men those who had only one or slight variation from the normal standard, C men those who had two, D men those who varied from the normal to the extreme in some or in all points (see Fig. 3).

Table 2 shows the 1,141 men divided into classes from A to D according to the excellence of their bodily mechanics, and a glance at the percentage of nervous symptoms indicates that men with good posture are distinctly less likely to have *tachycardia* and *variation* in blood pressure, although they just as frequently showed exaggerated knee jerks, sweating and flushing, and dermographia. There also seemed to be a relationship between *high blood pressure* and poor posture, for of 73 freshmen with systolic pressure over 140, 1 was in posture class A, 9 in B, 40 in C, and 23 in D. *Sinus arrhythmia* also was more

TABLE 2.—CORRELATION OF NERVOUS SYMPTOMS WITH POSTURE: PERCENTAGES OF A, B, C, AND D MEN

| Group | Tachycardia | Blood Pressure Variation | Other Vasomotor Phenomena | Dilated Pupils | Tremor | Exaggerated Knee Jerks | Acne | Neurotic History | Increased Muscle Tone | Decreased Muscle Tone |
|---|---|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % | % | % |
| A men (21) | 5 | 5 | 25 | | 19 | 10 | 5 | 10 | — | — |
| B men (178) | 22 | 12 | 21 | 5 | 7 | 10 | 15 | 20 | 6 | 7 |
| C men (597) | 23 | 12 | 16 | 10 | 7.9 | 11 | 29 | 14 | 3 | 5 |
| D men (345) | 28.9 | 17 | 23 | 11 | 4 | 9 | 30 | 18 | 4 | |

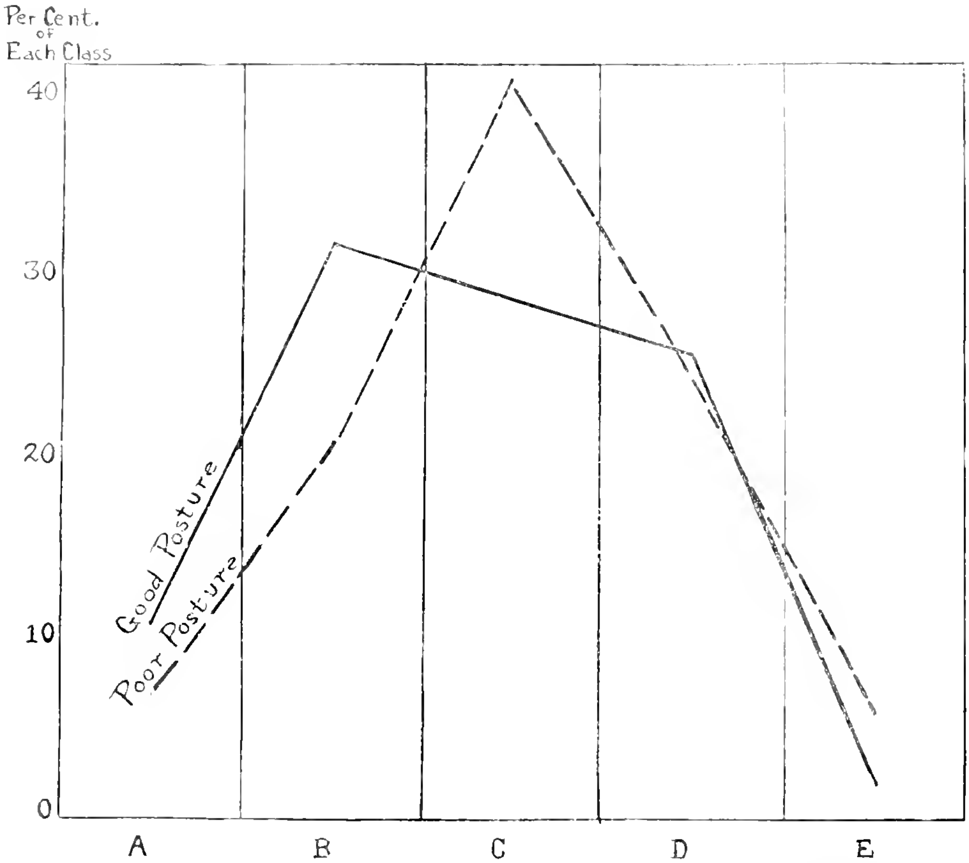


FIG. 4.—Group psychological test of 144 Business School men, made by Professor Starch.

Solid line indicates men of good posture from posture classes A and B. Broken line indicates men of poor posture from posture classes C and D.

A, B, C, D, and E are the grades obtained in the psychological test given by Professor Starch, A being the highest and E the lowest.

"Per Cent. of Each Class" indicates posture classes A and B grouped together, and posture classes C and D grouped together. The good posture men are considered as one class, and the poor posture men as another class. The percentage of each of these classes that obtained grades A, B, C, D, or E in the test was charted and a curve plotted.

commonly found among men with poor bodily mechanics; of 60 freshmen with sinus arrhythmia, none was in class A, 7 were in B, 27 in C, and 26 in D. Calculated in percentages, these relations are shown in Table 3, in which the percentage of men in each posture class is given, and also the percentage of each class which showed high blood pressure or sinus arrhythmia.

Finally, through the kindness of Professor Starch of the Graduate School of Business Administration, we were able to correlate the physical and mental examinations of a group of 144 Business School students. Only three men in posture class A took the psychological test, and they all attained low grades—one C, and two D. Of the 35 men with B posture who took the examination, 16 had honor grades (A and B), and only 1 failed in the mental tests. There were 74 men with C posture in the psychological tests, of whom 22 received A and B grades on the mental test, and 5 failed; while of the D men—32 in number—7 obtained honors and 1 failed. A rough graph of these figures indicates that men with good bodily mechanics stood a better chance of pass-

ing psychological examinations than did their less well set-up fellows (Fig. 4).

The general impression obtained from examining this large number of freshmen, and from talking to them informally, is that their problems have not yet defined themselves. If they had as yet had any emotional or intellectual problems that might be upsetting, they were inarticulate about them. In short, it seems too early for such examinations, and more valuable data could be obtained from a smaller group of men in a graduate school.

TABLE 3.—SINUS ARRHYTHMIA AND BLOOD PRESSURE VARIATION OF 585 FRESHMEN IN RELATION TO POSTURE

| Posture Class | Percentage of 585 | Percentage with Sinus Arrhythmia | Percentage with Blood Pressure Variation |
|---|---|---|---|
| A | 2 | 0 | 7 |
| B | 16 | 8 | 10 |
| C | 52 | 9 | 13 |
| D | 30 | 15 | 15 |


## Summary

History is the best guide to nervous instability—family history, past history and present complaints.

In a short fifteen-minute examination it is impossible to get a history with accuracy, and freshmen have few well-defined problems.

Vasomotor instability was found somewhat more frequently in the men with neurotic histories.

Tachycardia, blood pressure variation and dermographia were often found associated with each other and with exaggerated knee jerks. Men with albuminuria were likely to show all these symptoms.

Endocrinopathy was rare, but the small number of cases discovered showed more symptoms referable to the vegetative nervous system and less neurotic history and acne.

In men with bad mechanical use of the body, tachycardia, sinus arrhythmia, high blood pressure and variable systolic pressure were more common.

The men with good bodily mechanics passed better psychological examinations than did those with poor posture.


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# STATIC EQUILIBRIUM AS A USEFUL TEST OF MOTOR CONTROL*

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UNSTEADINESS of motor control in gait and standing posture is a sign of disease or disordered function which, as a readily observable symptom, has served physicians of all times. Romberg was one of the first to recognize and emphasize its importance and to make specific tests. In his classical study of *tabes dorsalis* he recorded the inability of his patients to stand securely with feet together and with eyes closed. In 1851 he wrote, "It is now ten years since I have pointed out this pathognomonic sign, . . . . since then I have found it in a considerable number of patients, from far and near, who have applied for my advice; in no case have I found it wanting." Romberg's (1) unqualified statements greatly stimulated the study of motor functions in relation to disease. This specific test of his was most simple to apply, but since a normal person always sways somewhat, even though he endeavors to stand motionless, the physician had to rely on his personal clinical standards in judging this symptom.

Dr. Weir Mitchell was among the first to make this test of station numerically accurate and objective. It is incidentally stated in a paper by Mitchell and Lewis (2), 1886, that patients were tested for their relative power to stand steadily by placing them in front of a horizontal scale graduated in inches and located on a level with the ears. The observer, about 10 feet away, was seated in order to avoid his own swaying and observed with one eye, making separate readings for lateral and anterior-posterior positions. They found among healthy subjects standing with the eyes closed that the anterior-posterior movement is usually the larger, being about 1 inch, while the lateral swaying is about ½ inch, and they concluded that any large increase was suspicious. Hinsdale (3) (4), working in Dr. Mitchell's clinic about this time, took graphic tracings of station. One of his methods was that of "attaching to the top of the man's head a flat piece of cardboard, upon which was stretched some smoked paper.* The subject was then placed under an index, which was free to move up and down in a fixed line, and which traced curves on the paper as the subject who stood beneath swayed in any direction."† This ar-

*The other method, the one which Hinsdale preferred, consisted in leading off from the head with two silk threads, one in the lateral axis and one in the anterior-posterior axis; these threads were carried around pulleys and made to move light levers writing on a kymograph. Thus, the two components of movement were registered and the extreme range of movement could be measured.

† The graphic registration of station as mentioned in later literature has usually been by this method, with the slight modification that sometimes the subject has had the writing point attached to the head while the smoked paper is suspended. The apparatus is referred to as the "ataxiagraph." The first illustration of it with which I am familiar is Dana, "Textbook of Nervous Diseases," New York, 1892, p. 38. Whipple, in his discussion of tests for steadiness of motor control (see "Manual of Mental and Physical Tests," Part 1, 1914, p. 156), gives the impression that the method and apparatus were originated by Crichton-Browne and used by him for detecting the presence of incipient or recent chorea. It is of minor importance but just as well to record that Sir James Crichton-Browne did not originate or use the ataxiagraph. To quote from a personal communication: "I cannot take credit for being the inventor of the ataxiagraph nor can I tell you who suggested it. I used to be content with the Romberg test and close observation, without instrumental aid." Such

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rangement came to be called the "ataxiagraph." The dimensions of a rectangle which would just contain the tracing when applied to it parallel to the anterior-posterior and lateral axes were used as the numerical result.

By this same method Bullard and Brackett (5) a little later measured the "static equilibrium" of 181 "healthy men who were undergoing a competitive physical examination." Subsequently, Hancock (6) used it as a means to study the motor ability of children; Bolton (7) tried the ataxiagraph in his investigation of the relation of motor power to intelligence; and Wallin (8) used it in studying mentally defective children.

More recently this graphic measure of static equilibrium has found use among those interested in different phases of military science. Melville (9), in his contribution to military hygiene, found it useful in studying the "attention position," in properly arranging the load of the soldier's equipment pack, and in recording fatigue after marching. Gates (10) found that unusual steadiness of motor control in standing was one quality in the make-up of a good marksman. The physical examinations especially planned for aviation candidates have contained such static as well as dynamic tests, the belief being, as noted by Head (11), that through testing the prospective aviator's ability to balance himself on his feet, the examiner might exclude some candidates who would have difficulty in learning to fly and to make successful landings. These tests by examining boards were mostly made without any use of graphic registration or instrumental aid, and the protocol for such an examination of a prospective pilot in the United States (12) usually answered the question of static control with the word "firm." The young men who were examined for this branch of the service were practically free from gross organic disease and the Romberg test, in place of revealing lesions, served mostly to test the condition of physiological or psychological control in the men. There were certain workers, however, interested in the most efficient selection of aviators who believed that some graphic or quantitative record of static equilibrium was a reasonable test to apply to such candidates and might prove to some degree to be a measure of aptitude for flying. Stratton (13) and Henmon (14) have shown, after accumulating a considerable amount of data, that while excellent control of station is by no means a proof or, so to say, a pathognomonic sign of an aviator, such scores do correlate well with the later flying school records of the men tested.* The recent experience with the static equilibrium test carried out in an accurate and objective manner is therefore such as to recommend its more general consideration as one means of measuring neuromuscular control in selecting men for work, or in assessing their condition after work or when subjected to various influences.

graphic registration for the involuntary movements during standing probably suggested itself independently to many observers. Leitenstorfer in "Das Militärische Training usw.", Stuttgart, 1897, credits it to Vierordt. I am indebted to Prof. F. H. Pike for the reference: H. Immermann, Deutsch. Arch. f. klin. Med., 1865-1866, *1*, p. 595, which also refers it to Vierordt: "Grundriss der Physiologie des Menschen, 1864, p. 408.

## Essential Features in the Measurement of Station

A graphic record of station theoretically provides three or more features which represent the swaying of the body

* Of the many psycho-physical tests applied to aviators by these authors, only one or two other tests give as high a positive correlation.

during the test period. These are: (*a*) extreme scatter or range of area covered; (*b*) actual length of the path traversed; and (*c*) number of movements or oscillatory rate of movement. The ideal score would be a combination and proper weighting of all of these. Practically, there appears no simple way to obtain the true length of path or oscillatory rate. The tracings on smoked paper, even though greatly magnified by projection, cannot be satisfactorily measured by a map tracer or similar method because of the utter confusion of the lines.* The authors just cited have contented themselves with measuring the extreme range of movement along the anterior-posterior axis and likewise along the lateral axis. To the use of this one feature as the expression of station there is the objection that subjectively the test is primarily that of standing motionless rather than of maintaining the vertex on a certain center. Within the area where there is no special strain or marked loss of equilibrium—and this area is relatively quite large—the subject tries each moment to avoid swaying rather than to return to the starting or central position. The fact is that the starting point rarely forms the center of the tracing and the subject has no accurate criterion for judging and locating the central position. The range is therefore a somewhat incidental feature of the record. Typical tracings show that most of the swaying movements occur within an area much smaller than the extreme range. These median or mean excursions should have their proportional part with the larger movements in forming the total score. Some mechanical means of automatically summing up all of the movements in terms of their anterior-posterior and lateral components thus appears desirable.

## Description of Ataxiameter

The apparatus here described has been in use since 1919 and has proved both adequate and practical as a means of recording static equilibrium in this quantitative way. For convenience it is called an ataxiameter in order to distinguish it from the ataxiagraph. While the ataxiameter provides a graphic record if desired, and in certain respects this is still useful, the unique feature of the apparatus is the possibility at the end of a test of reading off directly a score in millimeters for the accumulated or total amount of sway in each axis, forward, backward, left, and right. The three diagrams, A, B, and C, which comprise Figure 1, will make clear the simplicity of the device.

A square wooden frame D, 61 cm. in outside dimensions and adjustable vertically on the rigid pipe E (Diagram B), is secured at any desired height by two clamps, with winged nuts F, F. A movement added, such as is shown in side elevation in B, and in end elevation in C, is mounted under each corner of the wooden frame. From the collar Q, which connects with the subject's helmet, later mentioned, four fine silk threads pass, one to each of the four movement adders. At the end of each silk thread there is a weight of 5 gm. (See R in Diagram B.) Each

* Graphic tracings made by Hinsdale's "thread method" of recording lend themselves fairly well to the measurement of path length. Hinsdale seems never to have given attention to this feature since he confines his discussion to the extreme range and rate of movement. The general subject of tremor has usually been viewed in this way. See Dana, "The Clinical Characters and Diagnostic Significance of Tremor," *Med. News*, Phila., 1892, *61*, 673; and Eshner, "A Graphic Study of Tremor," *Jour. Exper. Med.*, 1897, *2*, 301, which refer to a considerable amount of literature on the topic.

thread passes over an aluminum pulley S, in Diagram C, which is 180 mm. in circumference at the bottom of the groove. The groove is wide and very smooth so that no fiber of silk will catch. in either direction. During the preliminary adjustment of a subject to the apparatus all the movement adders thus remain zeroized until the moment of actually starting the test. This is done

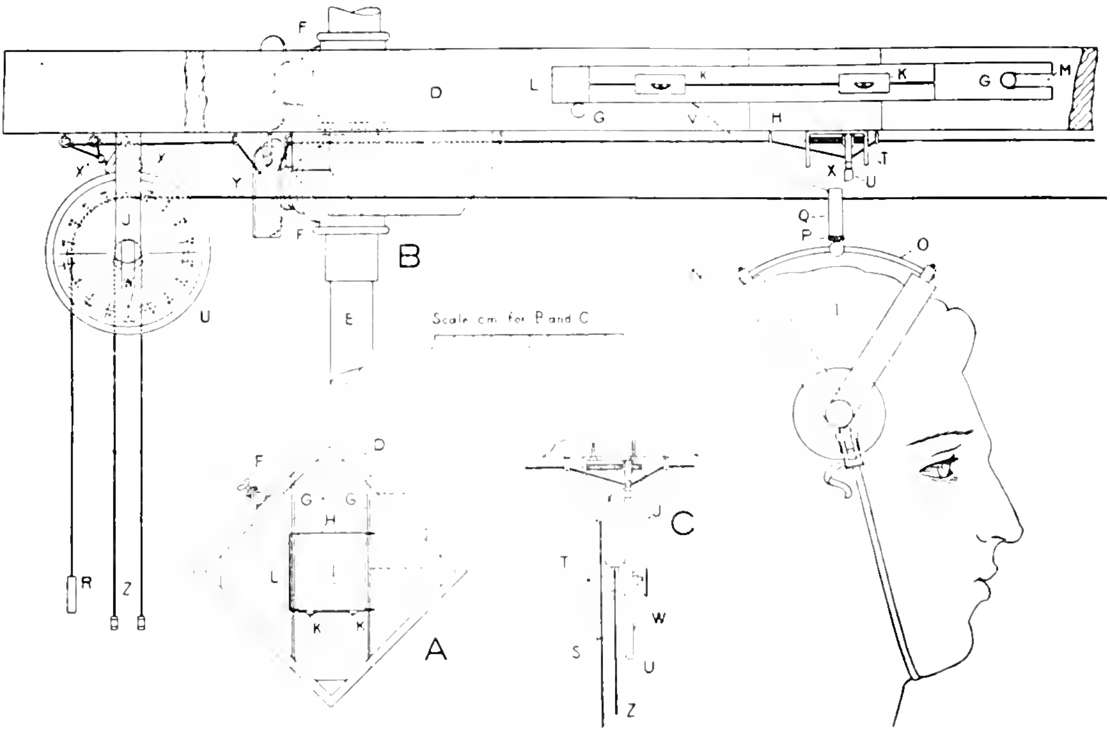


FIG. 1.—Diagram of the ataxiameter, an apparatus for measuring the swaying of the body when a man tries to stand motionless.

The small cone bearings are under very slight tension by the frame JT, which is made of brass strip. Secured to the same shaft with the pulley S is a larger thin aluminum pulley U. This pulley is 85 mm. in diameter and the periphery is knurled. Around the periphery is stretched a rubber band (3-inch by 1/2-inch bands have been found satisfactory). Two small pawls, X and X', are arranged above U, so that they may engage freely with the rubber band stretched about its periphery. Pawl X is always in contact with the pulley unless lifted by the operator at the time of zeroizing. With both pawls in contact, as in the figure, the wheel will not turn by unhooking the weight Y, and dropping it synchronously with starting a stop-watch. This weight, by drawing on a cord, lifts all four locking pawls and thus permits each adder to turn freely in one direction. The adder in Diagram B, for instance, would obviously accumulate all the anterior movements. Whenever the body sways backward, X holds firmly and the silk thread drawn by its 5-gram weight slips easily in the groove of the pulley, taking up all slack and making ready instantly to register any further movement in the forward direction. Movements as small as 0.5 mm. will be positively recorded.

When the test period has elapsed, the

weight is suddenly lifted to its hook and instantly all four adders are locked. The subject is released and the scales read. The graduations on a scale represent millimeters, and the reading is in reference to the index W. To indicate whether the scale U of a movement adder has been turned through one or more revolutions during any test period, a cord Z, with a small weight at each end, is passed over the shaft. The cord is graduated and the final separations of the weights show how many, or if any, revolutions (180 mm.) are to be added to the scale reading.

While, as just stated, all movements even though very slight, cause a positive turning of the adders, it must be remembered that the final total reading is not the exact length of the path of swaying but is the sum of all anterior-posterior and lateral components of these movements. The four threads attached to the subject's head represent four axes along which it is particularly arranged to have movements occur. If the swaying were from and through the center and only along these axes, the score and length of path would closely agree, indeed would be identical if the four adders were *infinite* distances from each other. Since actually opposed adders are 73 cm. apart in this case so that the apparatus will not be inconveniently large, a direct forward sway, for example, of 20 mm. from the center will produce a reading of 20 mm. on the adder back of the head and also a turn of 0.5 mm. in each lateral adder, the sum of 21 mm. having thus a positive error of 5 per cent. A similar movement of 50 mm. would show a plus error of 14 per cent., but it is seldom that a subject wanders so far from center. He does, however, sway in other axes than those which are directly front, back, left, and right, and roughly traces all sorts of plane geometrical figures.* It is evident that diagonal movements will produce a score for anterior-posterior and lateral components which may be 40 per cent. or more in excess of the actual path length. This difficulty cannot be removed by wide separation of the adders so long as they are arranged in the form of a square. It is therefore necessary to assume that in any one of a group of two-minute station tests the movements in all axes are about equally likely to occur, and only on this basis are the sums for the measured components comparable when dealing with a series of tests on the same individual or on a group of subjects.

The helmet N, in Diagram B, is made of two springs which terminate in leather-covered, padded disks, 5 cm. in diameter. It is not uncomfortable and is easily adjusted without entangling the subject's hair. On the rod O, connecting the two springs of the helmet, a stud P is arranged to be moved and secured as required so as to be central in the frame D, and vertical, ready to receive the collar Q. To this collar is attached a delicate spring with writing pen V, as well as the silk cords which actuate the movement adders. The smoked paper record sheet H is supported on two rods G, G, mounted in the wooden frame, and may be freely moved along the oral axis of the subject's head. Since the greater excursions of body swaying are forward and backward movements, this lateral adjustment of the paper permits several

* If all the movements could be assumed to be linear, then the length of path could be closely approximated as follows: Add together the forward and backward readings (thus treating opposed movement adders as constituting one meter) and square their sum, do the same for the two lateral readings, add the squares and take the square root of their sum. Since most swaying movements appear to be more curved than linear in character, it seems better to use the ataxiameter readings without any mathematical treatment.

records to be taken on the same sheet. The paper, by means of two clips K, K, is secured to frame L. This frame, bent up from iron strip, 3 mm. thick by 18 mm. wide, is open at one end with the prongs notched (see M in Diagram B) so that the record for protection may be tilted up against the wooden frame during periods of adjustment. The two prongs thus serve as springs and keep the kymograph paper taut while freely suspended. It is of prime importance to avoid friction and noise in recording the body sway for, as is well known, if the subject can avail himself of these secondary criteria he is almost certain to do so. The apparatus here described meets these requirements and without much attention remains in workable adjustment.*

### Factors Influencing Station

A number of factors influence the stability with which the erect posture may be maintained. Of these the following will be touched upon rather briefly: anatomy and physiology of the "attention position;" location of the feet and influence of footwear; height and weight; sex and age; respiration and heart-beat as possible producers of swaying; and the psychic factor. Melville has well stated some of the anatomical considerations. The human body is symmetrically disposed on either side of the sagittal plane, but asymmetrical as regards the coronal plane, which largely accounts for its possessing greater lateral than anterior-posterior stability. It is composed from above downwards of several segments (head, trunk, thigh, leg, and foot) which are not rigidly fixed to each other. Each segment possesses a center of gravity peculiar to itself which must be considered in relation to the point of support on the segment just below and to the area of support on the ground. "The maximum of stability and the minimum of constraint would be obtained if the various centers of gravity and the various points of bearing were all in the same vertical line, and if that line fell immediately in the center of the area of support" (9). Cleghorn (15) quotes the Weber brothers as stating that this condition is fulfilled and that erect posture requires no muscular effort for maintenance. The facts seem contrary to this. The head is so supported that it tends to fall forward, while the head and trunk together have a center somewhat behind the main support at the hip joint with the resulting tendency to fall backward. For the thigh the center is behind the coronal plane, but a little in front of the point of bearing at the knee joint with the tendency to fall forward; hence in the normal comfortable erect posture the quadriceps extensor is relaxed and the patella freely movable. Thus far the divergencies from the coronal hip-plane are 1 cm. or less, and the muscular activity necessary is little more than normal tonus. The point of bearing at the ankle joint is 5 cm. behind the coronal plane, consequently here is the location of greatest tension and it is chiefly the soleus muscles which keep the body from falling forward. Bullard and Brackett (5) found that in 80 per cent. of all their tests the position of the head at the end of the trial was definitely in front of the starting position. In the use of the ataxiameter it is found that the adder for anterior movements nearly always has the largest reading. The soleus muscles appear to relax gradually during the test, allowing the total center of gravity to shift forward toward the ball of the foot, with the result that the

* The apparatus may be obtained from Mr. Warren E. Collins, 584 Huntington Ave., Boston, Mass.

strain is much increased and fatigue rapidly develops, particularly if the subject continues his effort to stand motionless. Subjects who are to be tested should not be required to stand for a long while unsupported awaiting their turns.

and with the eyes closed. This has, of course, been done, as is revealed by Table 1 which is a summary of certain of the earlier data. Hinsdale, in 1887, with twelve normal adults found closure of the eyes to increase the sway in the two general directions an average of 54

TABLE 1.—SUMMARY OF EARLY DATA FOR STATION TEST

| Author | Subject Material | No. | Feet | Eyes | Time | Movement | |
|---|---|---|---|---|---|---|---|
| | | | | | | Ant.-Post. | Lat. |
| | | | | | *min.* | *mm.* | *mm.* |
| Mitchell and Lewis (1886) | Normal adults | ? | together | closed | [1] | 25[2] | 13[2] |
| Hinsdale (1887) | Normal adults, young | 12 | together | open | [1] | 55 | 20 |
| | Normal adults, young | 12 | together | closed | [1] | 46 | 25 |
| | Normal adult, young | 1 | shod | open | [1] | 39 | 6 |
| | Normal adult, young | 1 | bare | open | [1] | 73 | 45 |
| | Girls, from 7 to 13 yrs. | 25 | together | open | [1] | 28 | 27 |
| | Boys | 11 | together | open | [1] | 32 | 29 |
| | Blind inmates | 39 | together | | [1] | 43 | 36 |
| | Deaf-mutes, 14 to 24 yrs. | 17 | together | open | [1] | 22 | 24 |
| | Deaf-mutes, 14 to 24 yrs. | 17 | together | closed | [1] | 33 | 30 |
| | Adults, locomotor ataxia | 6 | together | closed | [1] | 75–175 | 75–150 |
| | Adults, cases of chorea | 10 | together | open | [1] | 60 | 37 |
| Bullard and Brackett (1888) | Normal men, 20 to 30 yrs. | 150 | V-form | open | ½ | 38 | 20 |
| | Normal men, 20 to 30 yrs. | 150 | V-form | closed | ½ | 35 | 20 |
| Hinsdale (1890) | Normal adults | 12 | together | open | [1] | 24 | 9 |
| | Normal adults | 12 | together | closed | [1] | 29 | 19 |
| Hancock (1894) | Normal children, boys 5 yrs. | 35 | together | open | 1 | 58 | 52 |
| | Normal children, boys 5 yrs. | 35 | together | closed | 1 | 67 | 58 |
| | Normal children, girls 5 yrs. | 22 | together | open | 1 | 58 | 50 |
| | Normal children, girls 5 yrs. | 22 | together | closed | 1 | 55 | 51 |
| | Normal children, boys 6 yrs. | 47 | together | open | 1 | 51 | 43 |
| | Normal children, boys 6 yrs. | 47 | together | closed | 1 | 57 | 52 |
| | Normal children, girls 6 yrs. | 18 | together | open | 1 | 57 | 37 |
| | Normal children, girls 6 yrs. | 18 | together | closed | 1 | 56 | 43 |
| | Normal children, boys 7 yrs. | 23 | together | open | 1 | 50 | 42 |
| | Normal children, boys 7 yrs. | 23 | together | closed | 1 | 60 | 54 |
| | Normal children, girls 7 yrs. | 13 | together | open | 1 | 39 | 33 |
| | Normal children, girls 7 yrs. | 13 | together | closed | 1 | 48 | 38 |
| Miles (1917) | Aviation candidates | 62 | V-form | open | 1 | 38 | 21 |
| | Aviation candidates | 62 | V-form | closed | 1 | 37 | 18 |

[1] The length of test is not stated; it was probably 1 minute.
[2] The extreme range of movement is represented by the values in these columns.
Data unpublished. Results taken into account in the work of Stratton (13) and Hennon (14). The subjects were in excellent physical condition.

Of the three or more types of sensory impressions usually involved in the maintenance of equilibrium (16), the influence of the visual factor is the most accessible to direct determination. Tests may be made with the eyes open

per cent. In twenty-five girls, ages 7 to 13 years, he states that the increase was about 40 per cent. From thirty-nine blind people he secured average scores which, on the basis of results for normal adults with eyes open, show an in-

crease of about 76 per cent., the performance of the blind thus being a little poorer than that of normal subjects with eyes closed. Seventeen deaf-mutes showed an average increase of 37 per cent., and he reports some increase in cases of chorea tested. Again, in 1890, Hinsdale found that a group of twelve normal adults showed increased swaying with eyes closed, amounting to an average of 65 per cent. In these tests the subjects first stood with eyes opened and then continued the test with eyes closed; whether or not they had previously made a short practice trial is not recorded.

Hancock, 1894, measured 158 children, ages 5 to 7; of these 110 were less steady with eyes closed. He tested with eyes open for one minute, allowed a rest of thirty seconds, and then recorded with eyes closed for one minute, and for his whole group an average increase was found of 13 per cent. Contrary to the foregoing results, Bullard and Brackett with their large group of young men in the competitive examination found slightly better (4 per cent.) stability with the eyes closed. Miles, 1917, testing aviation candidates also found an improvement of 9 per cent. when the eyes were closed. In the test of the aviators the men without preliminary practice stood at first with eyes open for one minute, then simultaneously with the command to close eyes the frame* carrying the smoked paper was given a quick lateral movement so as to separate the two tracings, and the man continued one minute with lids closed. The men had not been tested for station previously. The first minute was, to quite an extent, a period of adjustment, by the end of which they had begun to feel easier and were therefore in a position which they could more comfortably maintain. The unitiated, on beginning the station test, are apt to lean a little backward and gradually come forward, finishing in front of the center. As the second minute was really the latter half of the aviator's test, it would therefore be expected to show less anterior-posterior range. In spite of this difficulty and the elements of nervousness and practice, which must have been important also in the tests of Bullard and Brackett, 45 per cent. of the aviators were less steady without the use of vision.

The magnitude of the visual factor can best be shown by a group of measures on a subject who has had much practice in taking the test with closed eyes and has thus come to feel that he need not rely on vision. A fragment of such data given without discarding any trials is presented in Table 2. This subject had performed several hundred station tests always with closed eyes but no tests had been made for three months prior to those reported in the table. These tests were two minutes in length and successive, with a rest (sitting) of two minutes after each. The position of the helmet on the head was not changed during the series. The feet were in V-position—*i. e.*, heels together, inside lines of feet 45°. The data are given separately for each direction. The three tests with eyes open show a total average of 273 mm., with a variation of 2 per cent., while the average score for the usual test, that is, with eyes closed, is 508 mm., with a range of about 10 per cent. Aided by visual impressions of his movements in relation to the objects in the room, this practiced subject could more quickly stop or compensate the swayings and was thus able to improve his steadiness suddenly by approximately 45 per cent. Data for the two condi-

*This was an earlier apparatus and not the ataxiameter described in the present article.

tions show some minor characteristic differences other than in the amount of anterior-posterior and lateral sway. In both cases, the backward sway is less than the forward. With eyes shut it was 89 per cent. of the forward, with them open only 73 per cent. Vision does not correct the relative tendency to sway forward but increases it, probably because the fixation of an object in the room conduces to movement in that direction. Left and right sway are about equal in both cases, respectively, and the lateral sway is 60 per cent. of the anterior-posterior with eyes closed, while it is 64 per cent. with eyes open.* With vision playing a part, any lateral deviation tends to be instantly corrected rather than that the subject should hold motionless in the new position. It is futile to question the importance of vision as an aid to maintaining station, and the test for general use in measuring normal individuals will therefore be less complicated if made with eyes closed.

TABLE 2.—INFLUENCE OF VISION ON STATION AS MEASURED BY THE ATAXIAMETER ON A PRACTISED SUBJECT

| Axes of Movement | 1 Eyes Open | 2 Eyes Shut | 3 Eyes Open | 4 Eyes Shut | 5 Eyes Open | 6 Eyes Shut | Av. Eyes Open | Av. Eyes Shut | Per Cent. Increase Eyes Shut |
|---|---|---|---|---|---|---|---|---|---|
| | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | |
| Front | 100 | 185 | 95 | 174 | 94 | 145 | 96 | 168 | 75 |
| Left | 47 | 92 | 60 | 100 | 53 | 81 | 53 | 91 | 72 |
| Back | 60 | 158 | 76 | 138 | 75 | 154 | 70 | 150 | 114 |
| Right | 73 | 98 | 44 | 99 | 46 | 101 | 54 | 99 | 83 |
| Total | 280 | 533 | 275 | 511 | 268 | 481 | 273 | 508 | 86 |

We shall not be able, figuratively, to close the eyes of the "kineticstatic sense" (17). These impressions from the labyrinth are bound to function along with the great mass of kinesthetic sensations. Their relative prominence and importance in the test are of interest that we may have a clearer idea of what is being measured in station. In the first place, it is instructive to notice the experience of the young aviator* who is practically helpless if he has to fly in the dark or in a cloud and cannot use his vision by which to correct the position of his plane with the horizon. More than one aviator in recounting his experience has said: "Came out of the cloud to find the earth unexpectedly rushing up towards me." The wind pressure, vibration, and cold, and being strapped into a snugly fitting seat, cause the kinesthetic sensations of the aviator to be confused and blurred. Ideally the laby-

* The graphic tracings for eyes closed have average anterior-posterior and lateral ranges of 31 and 21 mm., while for eyes open, 39 and 9 mm. The tracings in the latter case appear to be made up of smaller movements as if the neck muscles were playing an important rôle.

* In recent years the work of von Stein, Ewald, Högyes, and Bárány has become familiar and through the impetus of certain problems arising from practices in military aviation has been supplemented by an enormous amount of data on the reactions following stimulation of the semicircular canals. These form the kinetic labyrinth, a receptor mechanism which seems well adapted for the detection and analysis of rotary motions. The static labyrinth, as distinct from the kinetic, through the pressure of the otoliths on the maculae of the saccule and utricle, is supposed to provide sensory cues as to the position or tilt of the head and to be acted upon when linear body movement is accelerated or retarded.

rinth should be able to take care of just such conditions but practically any impressions from it are not sufficiently strong to be a sure basis for orientation. Similarly in *tabes dorsalis* kinesthetic sensations are reduced or arrested. The tabetic can stand with some stability while he can see, but in the dark or with eyes closed the impressions from the labyrinth are too vague or weak to suffice.

Since the paper by James (18), it has been recognized that deaf-mutes are not subject to dizziness on being whirled around. They do not show the characteristic reactions following rotation, douching, or electrical stimulation of the canals. It is therefore reasonable to suppose in many cases that the labyrinth or the eighth nerve is destroyed. Yet these individuals commonly show satisfactory equilibration.† Hinsdale found that seventeen deaf-mutes (see Table 1) were all able to stand well with eyes closed, the averages of 33 and 30 mm. for anterior-posterior and lateral sway comparing favorably with results obtained with normal subjects.

The recent experiments of Griffith (19) are noteworthy in this connection. He concludes that the processes which constitute the experience of dizziness or vertigo are "(1) kinaesthesis from the eyes and neck and in the arms, (2) pressure from the region of the abdominal viscera, the chest and head, and (3) certain vascular processes which supply an obscure background and which give to the whole experience a characteristic shading." If ordinarily every tilt and turn, acceleration and retardation of movement, gave a clear-cut sensory impression from the labyrinth, these would constitute a prominent portion of our everyday sensory experience. We know this is not the case, but surely in vertigo, if at any time, this sensory quality ought to be sufficiently apparent to be recognized, at least. Griffith was unable, however, to discover any process which could be called "sensation of rotation" or "sensation of movement."

It is not surprising, then, that in maintaining erect posture with eyes closed, one is conscious of only kinesthetic and tactual impressions. The labyrinth must be assumed to be functioning during station probably by increasing the muscular tonus. It is doubtful if the slight changes in tilt during standing are sufficient stimuli to cause it to initiate different compensatory movements. If the average height of adults be taken as about 5 feet, 8 inches or 173 cm., then a sway at the vertex of 30 mm. is equal to just 1° of body tilt from the vertical axis. A continuous movement of this amount is unusual. Thus, there is provided a rather slight opportunity to stimulate a receptor mechanism which never supplies better than vague, weak impressions, even the existence of which are in doubt as sensory data. We are therefore warranted in considering station as primarily a test of muscular equilibrium against gravity. The swaying is perceived and controlled in so far as this takes places through the lower limbs almost entirely. The body's total center of gravity being a little above the horizontal line joining the heads of the femora and requiring to be kept somewhere near central to the area of support, the main task is evidently for the legs. There is but little movement at the neck and hips, as shown by testing subjects in the sitting posture, and it is not difficult to keep these muscles in

† They sometimes experience difficulty in the dark or when under water, but normals are not entirely free from such disturbances. Being in rough water in the dark is somewhat like flying in the dark.

equilibrium, having once gotten them into a comfortable relationship. The ankle is the point from which swaying takes place and, as is known from the work of Goldscheider (20), it is the least sensitive of the large joints to angular rotation, its threshold being from 0.75° to 1.50°. The soleus muscles are the ones most vigorously contracted to withstand the displacement of the center ahead of the support at the ankle. They are bound to vary in their contraction separately and between themselves. Here, then, is where the subject most actively exerts control to maintain a fine balance between these muscles and all that may act as antagonistics. This, in the final analysis, is the nature of the test.

Sensations arising from changes of pressure on different parts of the soles of the feet and of strain within the feet are of great use in controlling equilibrium. Severe anesthesia of the soles has long been known to produce swaying almost as marked as the typical Romberg symptom itself. Anything which interferes with the usualness of these sensations of pressure and strain will be reflected in decreased steadiness. Since it is customary for adults to wear shoes, station is more secure with the feet shod than with them bare. Hinsdale (Table 1) made such a test with one subject, and found a very great increase in the total range of sway on removal of shoes. The anterior-posterior sway was increased 87 per cent. while the lateral sway was multiplied more than seven times. Typical results with the ataxiameter may be reported for this factor. A normal young man of muscular type, wholly unpractised in the test, made ten trials with a total average of 895 mm. Then the shoes were removed for four trials which averaged 974 mm. The shoes were replaced and five trials made, the average being 813 mm. The average without shoes is 14 per cent. increase over the average figure with shoes. A practised male adult gave an average of 537 mm. for five trials with shoes, and an average of 667 mm. for five trials without shoes, an increase of 24 per cent. It is the habituation to shoes which aids us in standing motionless when they are worn.

After practice, swaying in most cases would probably be less with bare feet since the uncramped foot in contact with a flat floor would be better situated for sensing any shift in the center of gravity. Results obtained with an artist's model used to posing with bare feet illustrate this point. Two preliminary trials were made with the model wearing medium weight low-heeled, low-cut, walking shoes, her usual footwear; these trials gave scores of 559 and 515 mm. With the shoes removed, trials three and four gave scores of 398 and 392 mm., an average improvement of 26 per cent. The shoes were replaced and a fifth trial made, with a result of 594 mm. At another time with *cold* bare feet five trials, well separated with rest periods, gave an average of 474 mm. With the model, the station test may be considered well practised, owing to her occupation. Such facts indicate the importance of sensations from the feet, the necessity of using the same shoes throughout a series of tests on a subject, and the desirability of approximately controlling temperature.

Aside from training, a factor which aided the model in standing unshod was the fact that the feet thus covered a slightly larger area. The smaller the base of support the more difficult it becomes to keep the center of gravity comfortably centered. The Romberg test is made with the feet together, causing the sway to be exaggerated. Under these

conditions there are moments of distinct loss of balance, resulting in sudden large jerks of the body. Series of tests with the ataxiameter show more consistency between successive trials if the area of support is sufficiently large so that these great jerks very seldom occur. A group of tests, two or more of each kind, on a trained subject taken under comparable conditions, with shoes, show results which illustrate the influence of area of support on stability of station. It is seen (Table 3) that when the feet are close together or far apart the swaying is much increased. The greatest stability is found when the heels are about 20 cm. apart and the feet parallel or toeing outward. The V-position, used as the standard in tests reported in this paper, is nearer that of maximum stability than it is to the typical Romberg position. This makes for more consistent co-operation from all classes of subjects, as they do not feel themselves placed at a disadvantage in the test.

TABLE 3.—STABILITY OF STATION AS MODIFIED BY AREA OF SUPPORT

| Position of Feet | Total Score |
|---|---|
| | *mm.* |
| 1. Heels and toes together, Romberg position | 1,039 |
| 2. Parallel, separated by 20 cm | 421 |
| 3. Heels together, feet angle 45°, V-position | 587 |
| 4. Heels 20 cm. apart, toes 10 cm. apart | 500 |
| 5. Heels 20 cm. apart, toes 30 cm. apart | 421 |
| 6. Parallel, separated by 40 cm | 529 |
| 7. Left heel 25 cm. ahead of right on same line, toeing out | 1,213 |
| 8. Left heel 25 cm. ahead and 20 cm. laterally of right | 791 |

As the swaying is principally from the ankle, it is to be expected that the taller and heavier subjects will show greater unsteadiness at the vertex. The testing of a large number of individuals classified as to height and weight would be necessary to procure a correction factor for reducing the measures on several subjects to a strictly comparable basis. A hint of the influence of height and weight on recorded stability may be obtained from the following set of trials. A man 180 cm. tall, weighing 75 kg., made several trials of the station test with an average score of 499 mm. He then put on a long overcoat with weights well distributed in the pockets and elsewhere upon it, the total addition to his weight being 25 kg. The average for several tests made with the added weight was 606 mm. *i. e.*, about 20 per cent. more swaying for an increase of one-third of the body weight. Other tests were made extending the height by the use of a rod placed up the back so that the connection with the ataxiameter would be 198 cm. from the floor in place of 180 cm. With this artificial increase of 10 per cent. in height, the average score became 657 mm., which is approximately 30 per cent. more swaying than normal. From these trials the factor of height appears to exert more influence than weight in the ratio of about 4 to 1.

Since children are shorter than adults, they should show less swaying were other conditions the same.* Hancock (Table 1) finds that both boys and girls, ages 5 to 7, sway absolutely more than adults. With eyes open there is an increase in control with each year. The girls are in general steadier than the boys. Hinsdale measured girls and boys, 7 to 13 years, and found about the same range of sway as with the adults. The girls swayed less than the boys by about 10 per cent. The ataxiameter thus far has not been used especially to gather

* Fernald, in his article on The Defective Delinquent Class Differentiating Tests, *Am. Jour. Insan.*, 1912, 68, 537, has devised a standing test which he calls "Achievement Capacity Test." The subject stands on one foot and rests the other with as even a pressure as possible on a lever system which he keeps balanced as long as possible. Fernald states that the age factor is largely eliminated since the strength and development of the leg muscles most closely correspond with body weight.

data on sex or age differences, but the following data which are at hand are interesting:

| | Average Score mm | Variation % |
|---|---|---|
| 8 Girl Scouts, age 16 years.. | 848 | 16 |
| 11 Adult women ............ | 731 | 14 |
| 16 Adult men .............. | 745 | 24 |

The men covered a wider range in height and on the average were somewhat taller than the women, which is to their disadvantage in directly compared scores. On the contrary, having longer, broader feet, and so a larger base, they have this advantage of the women. The two factors tend to counterbalance and in these data the average results for adults of both sexes agree closely.

In attempting to stand motionless for just a few seconds it is natural to suspend respiration. Probably inspiration and expiration slightly shift the center of gravity along the anterior-posterior line. Graphic records (3) (4) made by using threads, connected with the subject's head, a method similar to the ataxiameter connection but which produces up and down tracings on kymograph paper, show the swaying, particularly the anterior-posterior, to be made up of a series of waves. These waves have a little resemblance to quite irregular respiration curves. Hinsdale concluded that the waves of swaying do not correspond wholly or fractionally with respiration rate. From the inspection of a number of such tracings made with the ataxiameter it is certainly clear that there are places in nearly every record where a direct correspondence seems evident. But the same records show that the swaying waves continue at approximately the same size and rate during intervals of fifteen to thirty seconds while respiration is suspended. While it is proved that these movements do not depend upon the acts of respiration, it is still possible that these waves may result from slight reflex contractions or alternating changes of muscle tonus associated with respiration. On the other hand, any process of balancing commonly results in something of a pendular movement. From these tests of Hinsdale and from the tests with the ataxiameter it is apparent that subjects should be advised to breathe normally during the station test.*

Such factors as apprehension, distraction, and suggestion have been noted by those who have employed the station test as being important influences on stability. Especially if the subject is blindfolded or has his eyes closed, it surely is obvious that the experimenter should not be walking about him or talking with him, nor should other individuals be allowed to move about in the same room watching or commenting on the test or on other topics. It is convenient to control attention and mental attitude somewhat by having the subject count silently with a clock ticking seconds. Since he knows the test is going to continue, for example, 120 seconds, he is able to apprehend its progress and will not begin shortly to feel that the experimenter has forgotten him. If a test like that of station has to be denominated a "general motor test," this is no warrant for giving it in a loose and general way, but should stimulate effort to achieve careful control. The discussion in the preceding paragraphs of some of the influencing factors is to emphasize that useful data, even in such a simple test as station, cannot be obtained without care.

* No waves for heart-beat could be identified in the tracings. "Aviation Medicine in the A. E. F.," Washington, D. C., 1920, p. 123, specifies that the breath should not be held during steadiness tests.

### Improvement of Station with Training

Hancock reports that "in 30 cases (children) the tracings were repeated at a later date, without material difference in size and fully as miscellaneous movement." Without referring specifically to station, Henmon, working with aviators, records that "practice effects are slight for daily tests over a period of fifteen days." A series of measurements were made in 1920 at the Nutrition Laboratory in order to determine the influence of training on the test. Twelve adults, nine women and three men, all of whom were regularly working at the Laboratory, were tested on the ataxiameter once each day between the hours of 8 and 10 A. M. for a period of twenty-one successive days, excepting Sundays and holidays.* The complete data cannot be reproduced here. The average for the first day was 694 mm., slightly better than the averages reported on page 328 of this paper. The twenty-one days may be divided into three blocks of seven days each. The following general averages are thus obtained: 643, 560 and 528 mm. They show progressive improvement in stability, the second group of days being 13 per cent. better than the first, and the third 5.5 per cent. lower than the second. The graphic tracings taken in connection with the ataxiameter readings were carefully measured to find out if there was a similar change in the gross range of sway. The three groups of seven days each gave total averages for all subjects:

| | | | |
|---|---|---|---|
| Anterior-posterior range (mm.) | 48.3 | 46.1 | 42.7 |
| Lateral range (mm.) | 20.0 | 18.3 | 18.9 |
| Rectangular area (sq. mm.) | 966 | 844 | 807 |

There was a decrease in the range of forward and backward movement while the lateral range did not change much during the last fourteen days. The rectangular area within which the swaying occurred decreased at first by 12.6 per cent. and then by 4.4 per cent. These improvements with training are substantially the same as those indicated by comparison of the ataxiameter readings, but these latter vary from each other, treating the seven-day groups separately, by an average of only 3.5 per cent., while the gross range of sway shows a variation of 6.5 per cent.—*i. e.*, nearly twice as much.

Eight of the subjects tested at the Nutrition Laboratory continued the tests for thirty-six days from the start, and after an interval of six weeks, including four weeks' vacation, were again tested for twelve days. It will be convenient to arrange these results in six-day groups or what may be termed weekly averages. This has been followed in Table 4 where the daily averages are all presented arranged by weeks during which the test was continued. The first value at the top of column 1, 640 mm., is the total average ataxiameter score for the eight subjects on the first day. The first result in column 2, 524 mm., is the average score for the seventh day and so on. The weekly averages provide the following series of scores: 574, 506, 486, 482, 489, 506, vacation, 530, and 490 mm. The variations of a weekly score from the daily scores of that week range from 2.5 to 5.1 per cent. with no regular or progressive change. The weekly scores indicate consistent improvement up to and including the second week in July—the fourth week of the tests—with a total decrease

* These tests were painstakingly made by Mr. F. S. Mills. His assistance and the co-operation of those who served as subjects are gratefully acknowledged. As usual, the tests were two-minute tests, with eyes closed and feet in V-position, in a quiet room, the subject counting silently during the period.

in swaying of 11.8 per cent. There was a slight loss in steadiness during the fifth week and a definite loss in the sixth when the factor of training was more than offset by the tedium of the test, and the physical laxness preceding vacation. After four weeks of vacation and two weeks of work at the Laboratory, this latter interval being judged sufficient time for getting back into routine, the tests were resumed. The score for the seventh week, 530 mm., is just about half way between that for the first and second weeks, showing a retained improvement from training of 7.6 per cent. after a lapse of six weeks. On the eighth week the score approached quite nearly to the previous minimum. While station as a motor test is found from these data to follow the law of improvement with practice, as is the case with all known voluntary neuromuscular performances, it improves rather less than the average of such tests (21) (22) (23). This is a feature which recommends its use in those circumstances where it is impossible to preface the testing by giving the subjects a long period of preliminary practice.

TABLE 4.—INFLUENCE OF PRACTICE ON STABILITY OF ERECT POSTURE

| Days of Week | Weeks during Which Tests Were Continued | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | June 17–30 | | July 1–31 | | | | | Sept. 13–25 | |
| | 1 | 2 | 3 | 4 | 5 | 6 | | 7 | 8 |
| | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | *mm.* | | *mm.* | *mm.* |
| 1 | 640 | 524 | 473 | 489 | 465 | 496 | *Vacation 6 Weeks* | 560 | 525 |
| 2 | 588 | 527 | 449 | 456 | 488 | 532 | | 559 | 527 |
| 3 | 560 | 545 | 510 | 490 | 534 | 518 | | 518 | 487 |
| 4 | 543 | 491 | 498 | 483 | 492 | 504 | | 511 | 481 |
| 5 | 543 | 484 | 504 | 471 | 478 | 495 | | 520 | 464 |
| 6 | 570 | 467 | 484 | 503 | 476 | 492 | | 514 | 457 |
| *Av.* . . . | 574 | 506 | 486 | 482 | 489 | 506 | | 530 | ·90 |

## Summary

The ataxiameter as a means of carefully measuring station in man has been used at the Nutrition Laboratory for investigating the influence on neuromuscular control of such conditions as those before and after the taking of food, physical weakness associated with diabetes, prolonged exposure to cold, fatigue resulting from muscular work, and the ingestion of dilute alcoholic beverages. Data could be given from such experiments to illustrate the sensitiveness of the station test and the type of results which may be expected from its use. But such fragmentary data tend to mislead the reader as to their bearing on the problems with which they deal and can best be withheld for publication in their proper connection. It has been the object of this article to call the attention of those interested in mental and physical tests to the static equilibrium or station

test as one well deserving consideration for general use.

1. A general review is presented, indicating some uses previously made of the station test.

2. A relatively simple apparatus called, for convenience, an ataxiameter, is described. This automatically accumulates all the anterior-posterior and lateral components of the movements directly in millimeters of sway, and provides a convenient method for making the test.

3. The anatomical and physiological considerations which influence stability of station and the quantitative influence of several of these factors have been shown by original data. This constitutes a description of how the test should be made.

4. Results for a long series of measurements are presented and demonstrate that, although subject to practice, station is not very markedly improved by training.

5. The test is put forward as a convenient and sensitive measure for variations in the efficiency of the neuromuscular mechanism of man.

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# CENSUS OF SAFETY AND HEALTH WORKERS

All industrial physicians and surgeons, industrial nurses, and other persons engaged in industrial health work are to be included in the census of safety and health workers now being taken by the National Safety Council in all parts of the country. Although health work in industry, along with safety, has made great strides in the past few years, it is not at present known how many persons are engaged in either of these activities, who they are, or where they are located. This is the first time an attempt has ever been made to list all the industrial safety and health workers. Public safety workers will also be included in the census.

It is believed that the results of the census will give a good indication of how extensive the safety and health activities now being carried on are. The census will include not only members and employees of members of the National Safety Council, but all persons engaged in industrial safety and health work whether connected with the Council in any way or not. The Council has almost as deep an interest in industrial health work as in accident prevention, and is very closely allied with the American Association of Industrial Physicians and Surgeons. Many health workers and companies employing health workers are numbered among the Council's membership.

Industry in general and the nation at large will profit from the results of this census. It will enable the Council to find quickly speakers on industrial and public safety for any occasion in any locality; authors for special articles on accident prevention; writers of safety text-books; lecturers on accident prevention and industrial health work for universities and colleges. The Council at present continually receives requests from industrial companies, municipalities, civic associations, clubs, schools, colleges, and other organizations for help in finding speakers or writers on safety subjects. The census records will greatly increase the facilities of the Council for filling such requests.

Every reader of this publication who is professionally engaged in industrial or public accident prevention or industrial health work — whether he is devoting all or only part of his time to accident prevention — is urged to assist in the taking of this census by sending to the National Safety Council, 168 North Michigan Avenue, Chicago, his name and the other data requested in the Council's census form, which follows:

Name ..........

Company or organization ..........

City .......... State ..........

Nature of company's business ..........

Is safety your principal work? ..........

Please check other activities you engage in:

| | |
|---|---|
| Fire protection | Engineering (other than safety) |
| Health and sanitation | Legal |
| Workmen's compensation and claims | Insurance |
| General executive (such as manager or superintendent) | Welfare  Educational |
| | Industrial relations |

How long have you been in your present position? ..........

Technical or other special education? ..........

Signed ..........

Title ..........

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## COMMON COLDS IN RELATION TO INDUSTRIAL HYGIENE*

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It is generally recognized that the common "cold in the head" and its sequelae are among the most frequent causes of loss of time from work. The common cold as a disease is rather held in contempt by the average individual. As far as his experience goes it is a more or less limited, harmless process and something to be endured with what equanimity one can muster. His experience does not include the possible sequelae which may occur and which may cause serious loss of time, health, and even death.

In industrial life a great many of the common colds are rather an irritative process set up by unfavorable surroundings—*e.g.*, exposure to chemical irritants, cold, dampness or extreme heat—necessary to the particular occupation at which the individual is employed. Prolonged exposure to such conditions does, to be sure, render the individual susceptible to infection.

### SYMPTOMS

Properly speaking, the term "cold" should be reserved for a particular disease with definite symptoms,—a disease which Dr. Wendell Phillips† describes as follows:

> An attack of acute rhinitis [or cold in the head] is usually ushered in by sneezing and a sensation of nasal stuffiness or obstruction. The obstruction is associated with a burning sensation in the nose, tenderness over the forehead upon pressure, heat in and below the eyes, lachrymation, a general sense of dryness of the mouth and throat, and often perversion or absence of the sense of smell and taste. Soon after the onset, the general symptoms supervene, such as languor, fatigue, chilliness and prostration. The general disturbances may be slight, but very commonly they are prolonged and distressing on account of the predominance of one or more of these manifestations. After a few hours the nasal obstruction becomes associated with a profuse watery discharge and the mucosa which was at first hyperemic becomes so much infiltrated that one or both nostrils may become entirely occluded. The nasal obstruction commonly alternates from one nostril to the other. The serous exudate soon changes to a mucopurulent and therefore thicker discharge as a result of the increasing admixture with cellular elements, and meanwhile it diminishes in quantity. The discharge often possesses an irritating quality which produces excoriation of the skin about the nasal orifices and upper lip. There may be a slight rise of temperature and

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†Phillips, W. C.: Diseases of the Ear, Nose and Throat, Medical and Surgical. Fifth revised edition. Philadelphia, F. A. Davis Company, 1919, p. 493.

considerable loss of appetite. . . . Mouth-breathing is the rule, especially during sleep, resulting in great dryness of the pharyngeal and laryngeal mucosa . . . The swelling of the mucosa gradually subsides, and the secretion slowly diminishes and finally disappears; the attack usually terminates after a week. . . .

Such is the picture of the true cold in the head with which we are all familiar. It is necessary to have these symptoms well in mind in order to differentiate between the true infections and the cases of acute rhinitis, or coryza, from other causes, which never go on to pus formation unless infection supervenes.

### Modes of Infection

Two avenues of infection are recognized:

1. It is well known that potentially pathogenic bacteria may lead a saprophytic existence upon the pharyngeal mucous membrane of healthy individuals. Under appropriate circumstances, these bacteria become the active agents of infection. Many causes may be enumerated for the lowered resistance which opens the door for active infection—such as, for example, physical exhaustion from overwork, dissipation or disease, and the deterioration of health which follows prolonged association with insanitary surroundings. As examples of important insanitary conditions predisposing to infection, vitiated air, overcrowding, defective diet, sedentary habits and neglect of body cleanliness may be mentioned. Prolonged chilling of the body from constant drafts may result in a temporary lowering of resistance, during which the bacteria may gain a foothold and acute infection develop.

2. A more frequent avenue of infection is by direct contagion from a person in an acute attack, in which instance there is a direct implantation of pathogenic bacteria. The chance of infection will depend upon the virulence of the bacteria and upon the general condition of the individual as well as upon the local condition of the upper respiratory tract. It is evident that individuals subject to the conditions mentioned in the previous paragraph are much less able to resist such contagion, which is carried by sneezing, coughing, embracing, speaking at close range, and possibly by towels, drinking cups and other utensils.

Surroundings favorable to contagion are found in ill-ventilated rooms, halls, or places of work, and in the close contacts necessitated by crowded trains and trolley cars. It has been found that in hot, dry, crowded rooms, such as ill-ventilated theatres or meeting halls, the mucous membranes over the turbinate bones and nasal septum swell, become turgid with blood and tissue lymph, and covered with thick secretion. In such crowded places massive droplet infection is likely to occur. On going out into cold, moist air, the blood vessels constrict and the nasal mucous membrane becomes chilled but remains swollen with tissue lymph. This condition of the mucous membrane affords a suitable condition for bacterial proliferation. Such an explanation is in harmony with the increase in incidence of upper respiratory diseases during the cold weather.

### Treatment

*Prophylaxis.*—The following suggestions for the general care of the body will be found helpful in preventing attacks of cold in the head: Lead as vigorous and healthful a life as possible with adequate sleep, food, exercise and fresh

air. Bathe daily. Keep the house sufficiently warm to be comfortable but not overhot or overdry. Avoid contagion from infected persons, remembering that respiratory diseases are communicated chiefly through droplets of mucus sprayed into the air through coughing, sneezing and speaking. Avoid crowding in hot atmospheres.

*General and Local Treatment.*—Treatment may be divided into three stages to correspond to the stages of the infection: (*a*) measures directed toward aborting the infection in the prodromal period; (*b*) relief from the profuse discharge and turgescence during the acute stage; (*c*) oversight of the last stage in order to hasten the recuperative process and to forestall complications.

(*a*) As has been mentioned, it is extremely difficult to induce persons suffering with an acute cold to submit to the form of treatment which mitigates its severity, lessens its duration and almost surely guarantees immunity from troublesome and even serious complications. In the majority of cases the prodromal symptoms are not recognized and relief is not sought until the disease is well established. If these symptoms, such as dryness of the mouth and throat and even of the nose, a sense of stuffiness in the nose, headache, etc., are recognized, a hot bath, a hot lemonade and ten grains of Dover's powder followed by a saline cathartic in the morning will often abort or distinctly decrease the severity of the attack. This treatment is more efficacious if the person will consent to remain in bed, or at least in the house, for two or three days, and possibly repeat the above treatment on the second day. It is important to remember that this treatment is only to be instituted upon retiring, as the object is to induce a profuse perspiration.

(*b*) Opinions differ as to the advisability of local treatment during the acute stage; the dangers of irrigations and sprays are magnified, and well so, as indiscriminate and unskillful douching and spraying often lead to untoward results, spreading the infection to quite as great a degree as they remove it.

The chief indications for treatment are the profuse discharge and the swelling of the mucous membrane. The watery discharge may be controlled to some extent by the administration of belladonna in the tincture, ten drops every two hours until a sense of dryness is noticed. Belladonna and camphor are the principal constituents of the common rhinitis tablets which, while not curative, give some relief when properly administered. For the temporary relief of the turgescence of the mucous membrane, the local application of adrenalin in the form of a light spray, in the strength of 1:5,000 will prove the most useful. The resultant shrinking of the lining membrane allows a more thorough removal of the excess secretions. If, after the tissues have contracted, an oily spray containing menthol and eucalyptol is used, an added sense of relief is produced. Forcible spraying in ignorant hands is worse than no spraying at all. The vogue of aspirin among the laity extends, of course, to the common cold. All that can be expected of this, however, is to relieve the headache.

(*c*) In the last stage the secretions have become thick and adherent and are difficult to expel, the more so if irregularities of the septum are present, around which the secretions collect. The presence of these retained secretions keeps up the inflammation and infection which may gradually extend to the accessory sinuses, and it is therefore good practice to aid in their removal. Shrinking the turbinates by use of the adrena-

lin spray may be followed by a bland wash which mechanically removes the thick mucus. This washing should be done by an experienced person, in one of two ways: first, under direct inspection with a hand atomizer which throws a small non-forcible stream; or, secondly, by means of gravity from a douche bag. If the first method is chosen the fluid is heated to body temperature, the patient directed to hold his breath, and one portion of the nasal cavity is washed, immediately after which the head is thrown forward over a basin and the fluid is allowed to drain back. After all excess of fluid has been removed, the opposite nostril is closed with the finger, and the remaining fluid with the washed off pus and mucus is forcibly expelled. By the gravity method the same process is gone through with, excepting that the head is thrown forward during the whole performance. This method is not, of course, carried out under direct inspection. Coughing, gagging and swallowing while excess fluid is present must be guarded against. Such difficulties are usually occasioned by a fluid of improper temperature or by the patient's breathing during the operation and thus allowing the fluid to escape into the oropharynx or even into the larynx.

It is axiomatic that no irritating fluids should be used as they only increase the inflammation. Any irrigating medium in sufficient strength to kill bacteria will result in increased irritation of the nasal lining. It must be emphasized that it is only the mechanical removal of the irritating secretions that is desired. Non-irritating, simple alkaline washes, such as liquor alkalinus antisepticus (N.F.), or normal physiological salt solution, may be used for this purpose. (The latter is simply one teaspoonful of salt in a pint of water, and is absolutely non-irritant.)

## Complications

The nasopharynx is almost invariably involved in every case of cold, and an associated acute tonsillitis is common. The infection may also extend to the larynx and to the bronchi. In certain individuals an attack of the common cold predisposes to prolonged bronchial inflammation. Infection of the accessory sinuses may occur in the early stages, particularly during a virulent infection. This is especially true of the influenzal infections. Acute involvement of the sinuses is indicated by severe pain and prostration. Persons thus affected are confined to bed and do not, as a rule, come under the care of the industrial clinic.

I wish to lay particular stress upon the colds which do not clear up after ten days to two weeks. In cases of this kind we are probably dealing with retained secretions—a subject which I have already discussed—or with a sub-acute infection of the accessory sinuses. Sub-acute infection of the accessory sinuses is usually indicated by a continual discharge from the nose. The discharge is more likely to be unilateral, since one side of the nose is involved more frequently than both sides together. Contrary to the usual idea, pain is not a necessary accompaniment of sub-acute sinus infection. Frequently the antrum, or maxillary sinus, acts as a reservoir for residual pus from the infection. The typical picture of such a condition is presented by persons giving a history of having had a cold two to four weeks before, which has not cleared up. There is a constant one-sided nasal discharge, and the head feels dull and heavy. The person cannot think or concentrate, there is a feeling of lassitude, the voice has lost its reso-

nance. Individuals complaining of these symptoms should be referred to a specialist, as very simple procedures will give relief; neglect frequently means loss of efficiency and, later, further loss of time from more radical procedures which may become necessary.

The common cold may be complicated by deafness and abscess of the middle ear, resulting either from direct extension of the process to the eustachian tubes and thence to the middle ear, or from the forcing of infected material into the tubes through careless douching and spraying of the nose. Inexpert use of the handkerchief during an attack of cold may result in infection of the sinuses or the middle ear. The act of wiping the nose with the handkerchief before one has finished blowing is almost a universal habit. This results in raising the pressure in the nose and nasopharynx and in forcing infectious material into the sinuses and eustachian tubes. We may well take a lesson from the laborer who closes one nostril while clearing the other; this may perfectly well be done while using the handkerchief. For the same reason, too, forcible blowing to expel secretions should be guarded against.

Considerable emphasis has been laid upon the common cold and its recognition, as it is frequently mistaken for acute rhinitis, or coryza, and vasomotor disturbances. An acute rhinitis, or coryza, is a temporary turgescence of the nasal mucous membrane, often accompanied by sneezing and a profuse watery discharge. Thus far, it resembles the common cold; but careful questioning does not bring out a prodromal stage of dryness or tickling in the nose or throat; there is no general lassitude, chilliness nor headache. The symptoms begin suddenly, last for a few hours, and disappear as suddenly as they appeared. In other words, while the way is paved for infection, such infection does not occur. These attacks result from various causes. Attendance at the theatre, or other gatherings where the air becomes vitiated and filled with dust, frequently gives rise to such a train of symptoms, which may last from twelve to forty-eight hours. Exposure to irritating chemicals and dusts in the industries may be the cause. Exposure to cold and to drafts gives rise to a temporary vasomotor disturbance. Any drug, such as aspirin or rhinitis tablets, taken at this time, is promptly proclaimed as curative. This is probably one reason why so many and various drugs have been advised for treatment. The essential difference, then, to be remembered between the common cold and acute rhinitis is that, in cases of the latter, infection does not occur.

With these conditions in mind, it becomes evident that irritating antiseptics and gases should not be used as a routine for these symptoms. Not infrequently such procedures set up a true inflammatory process in the nasal chambers upon which infection is bound to occur. The formalin chamber, to my mind, is not good treatment. Formalin is a very active irritant to the mucous membrane and, in sufficient concentration to be bactericidal, cannot be tolerated by the human body.

Recent studies in anaphylaxis have shown that prolonged vasomotor disturbances, simulating colds, may be caused by various substances which are ingested or inhaled. Hay-fever is the most common example. Certain individuals are susceptible to the dust inhaled from horses, cats, dogs, and feathers, or to various foods which are ingested. Chemists working in drugs, as well as workers in leather, may be susceptible. Face powder is frequently at

fault. Persons thus affected complain of prolonged colds with nasal obstruction, sneezing, and profuse discharge.

### Summary

1. Every person complaining of nasal obstruction, sneezing and discharge is not suffering from a cold in the head. Learn to differentiate.

2. A careful history will be helpful in the diagnosis. The duration of the symptoms will indicate to a certain extent the character of the affection. A long duration points to a complication or to some disturbance which is not a cold. Inquire into the character of the person's work, the conditions under which he works, etc.

3. Differentiate the three stages of a cold and treat the patient accordingly. Do not use irritating antiseptics at any stage.

4. Any case resisting treatment for from two to four weeks should be examined by a rhinologist.

# INFECTIOUS ARTHRITIS OF THE SPINE*

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## INTRODUCTION

THE detection and treatment of cases of infectious arthritis localized in the spine compel the interest of the industrial physician for two important reasons: (1) the insidious character of the disease with attendant difficulty of diagnosis and treatment; (2) the economic aspect as presented in the direct cost and disability to the victim and the indirect cost to the employer. The course of the ailment is characterized by progress without outward symptoms until a stage is reached when an act of overexertion causes severe pain and thus reveals the disorder. Preventive measures are then impossible and a long period of expense for employee and employer follows.

The incidence of cases of this disease is not large, thereby limiting the development of means by which it might be readily detected upon entrance examination. Proper placement in most cases would have permitted the employment of the patient for a considerable period upon work which was suitable. Instead, disability occurs and expense begins. It is admitted that, in the last analysis, the function of the industrial physician is to lessen production costs due to illness by prompt analysis and treatment of both major and minor ills. That this end may be served, information based upon special cases has been compiled as to the general nature of the disease, and as to special characteristics brought forward by the cases under observation.

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## ETIOLOGY

Infectious arthritis is an inflammation of a joint caused by the presence of bacteria or their toxins. Localization in the spine is, of course, subject to the same causes which produce the disease elsewhere. Lessened local and general resistance promote the activity of the bacteria and affect the progress through the various stages of the disease. A guide to the focus of infection may be tonsillar inflammations, past or present, the condition of the teeth, or the symptoms of a discharging sinus. The condition of the prostate, the seminal vesicles, and the gallbladder should be investigated. There is also the contributing factor of defective assimilation resulting in the absorption of toxins from the large intestine. The X-ray is invaluable in detecting the source of infection.

## PATHOLOGY

The pathology of infectious arthritis of the spine may be classified into three stages, the progress from one to the other depending upon the severity of the disease and the physical resistance of the patient. The first stage, which is present in the milder cases, consists of a slight inflammation of the synovial membrane within the joint. In the more severe cases, erosion of the intervertebral disk occurs, and in the most serious cases there is destruction of the vertebra itself. In determining the pathology of the disease, the X-ray is of great importance. By proper control of the development of the negative, lesions in

the soft parts may be discerned and the stage of destruction or erosion of the cartilages in the affected area can be determined.

### Clinical Course

Cases of infectious arthritis of the spine are revealed chiefly by routine examination or by an industrial accident. The onset is usually acute, and patients report that prior to an act of overexertion they were in good health. Accompanying the strain is intense pain as the muscles which have been serving as a support assume a state of tonic contraction to prevent further irritation or injury. Rigidity, the military or poker back, quickly develops, and any movement occasions a considerable amount of pain. It is apparent at once that the physician is confronted by a serious problem and he is handicapped unless there has been physical examination or history of disease or injury referable to the spine.

### Treatment

The purpose of treatment is to eradicate the source of the disease and to apply support and corrective measures to the diseased area. Examination is made for all possible foci of infection, and wherever any focus is found remedial measures are administered. A plaster jacket so designed that the muscular support will be relieved is applied at once. When it becomes obvious that the disease is in a quiescent state, the patient may be equipped with a spring back brace and permitted to return to employment.

### Report of Cases

The cases of infectious arthritis of the spine to be presented have been selected as representative of the characteristics of the disease. They illustrate the extensive cost of this sort of disability and the almost certain resulting incapacity for ordinary forms of employment. Cases of this type are of serious concern to the industrial physician because he bears a responsibility to his employer in the control of the physical well-being of the operating force which should result in the prevention of excessive disability costs. From the purely professional point of view, the disease is of especial interest because in the early stages when it is most amenable to treatment there are few, if any, symptoms. An accurate diagnosis is complete only when the clinical diagnosis is corroborated by the X-ray. The value of information relating to infectious arthritis of the spine from the standpoint of the employer and employee is self-evident.

In outline, therefore, the importance of the affection to those involved appears as follows:

1. *To Employer:*
   (*a*) Effect on premium rate
   (*b*) Cost of treatment and management of case
   (*c*) Production delays by absence of employee
2. *To Employee:*
   (*a*) Long disability
   (*b*) Great suffering
   (*c*) Loss of wages
3. *To Physician:*
   (*a*) Difficulty of diagnosis
   (*b*) Difficulty of treatment
   (*c*) Responsibility to employer and employee

The points thus shown are exhibited in the cases which follow.

Case 1.—S. B., a Greek workman, aged 35.

*History.*—On November 28, 1917, S. B., a Greek of relatively sturdy physique, being 5 feet 2 inches tall and weighing 123 pounds, suffered a back strain while in the act of pushing an industrial truck. The extra exertion required to move the truck over a doorsill occasioned the strain. Upon examination when he was hired, this man was considered physically capable of performing the work to which he was assigned.

After receiving treatment he resumed regular work on December 3, 1917, and continued until December 17, 1917, when he was compelled to stop work because of the severe pain in his back. During this period, daily calls were made at the company hospital where local treatment was given.

Complete disability continued until April 3, 1918, when the patient returned to work as elevator operator, a task which required little exertion. Excessive pains in the back caused him to stop this work April 11, 1918. He remained idle until May 8, 1918, on which date he was again placed in the position of operator of an elevator equipped with automatic gates and electrically propelled. A minimum of effort was therefore required. He was forced to stop this work on July 2, 1918, and up to the date of writing has not been employed.

*Physical Examination.*—At the time this man was hired there was no marked evidence of physical weakness. Slightly defective vision in one eye, moderate right septal deviation, teeth fair but neglected, first degree herniae, were the only defects recorded. Shortly after the injury there was tenderness in the lumbar region and motions in all directions were markedly limited and painful. The patient stood with distinct list to the right and there was an area of rigidity involving the tenth dorsal to the fifth lumbar vertebrae.

*X-ray Examination.*—The negative showed evidence of hypertrophic arthritis involving all the dorsal and lumbar vertebrae.

*Treatment.*—In the early stages, symptomatic relief measures were applied, consisting of baking, massage and strapping. Later a plaster jacket was applied and worn by the patient for eight weeks. Permanent equipment in the form of a steel brace was then supplied and the patient when last observed was still dependent upon its use. The focus of infection seemed to lie in the teeth to which remedial measures were applied. The patient was also given general tonic treatment as his suffering occasioned much loss of weight and strength.

*Results.*—From the day of the accident until the present writing the cost of this disability has been approximately $2,200, and in all probability the full legal amount of $4,000 will be expended. In addition, the Associated Charities have rendered considerable financial support. The patient has suffered complete incapacity for all ordinary forms of work and will be a constant hazard to himself and to his employer in even the milder types of labor.

Case 2.—C. B., an Italian workman, aged 33.

*History.*—C. B., an Italian with the average physical development of men of this race, 5 feet 4 inches in height and weighing 140 pounds, wrenched his back while delivering coal on October 5, 1920. His routine occupation was that of trucker, at which he had been employed for two years, and it was in the course of his regular work, as he was emptying a 100-pound bag of coal through a window in a shed, that he experienced severe pain in the lumbar region.

The patient, although suffering considerable pain, was able to continue work that day. The pain became more severe, however, and medical attention was sought. Treatment for back disorder was administered but up to the present time the patient has been forced to remain idle.

*Physical Examination.*—The patient appeared fairly well developed and nourished, and showed no peculiarity aside from the condition of his spine. There was a marked list to the left in his posture, together with evidence of lower dorsal and lumbar left scoliosis. Motion was restricted to about half normal in all directions, and there was no appreciable backward movement below the tenth dorsal vertebra.

*X-ray Examination.*—X-ray examination was conducted by three different physicians. In the views furnished by two of these physicians, there appeared left lumbar scoliosis, while the negatives from the third presented both scoliosis and infectious arthritis of the second lumbar vertebra manifested by considerable destruction of the body.

*Treatment.*—The usual measures for relief—namely, strapping, massage and baking—were administered but the patient continued to suffer severe pain. A plaster cast was then applied and allowed to remain in place six weeks. At the expiration of this time, a spring brace was provided for permanent use. The focus of infection could not be located, and the patient denied ever having suffered venereal disease.

*Results.*—Since the day of the accident, no work of any description has been performed by the patient. In all likelihood, this is a case of permanent disability and will entail a considerable sum for settlement. Already $1,200 has been expended for compensation and medical care.

Case 3.—F. W., an Irish workman, aged 19.

*History.*—On August 13, 1919, F. W., a strong, well-built man, strained his back in lifting rods of iron from a truck to an elevator, an act which was in the course of his routine occupation. He continued to work

for two weeks, then he was forced to discontinue by reason of the severe pains in his back.

Remedial measures were applied and the patient returned to work in March, 1920, but was only able to continue for two weeks. Since that date he has remained incapacitated for ordinary forms of labor.

*Physical Examination.* — The patient presented a large, over-developed condition in relation to his age, being 17 years old and weighing 170 pounds. On general examination, no peculiarities were observed except that the teeth were irregular and neglected and hallux valgus was present on each foot.

The patient stood very erect and the natural lumbar curvature was absent. The legs were equal in size by actual measurement, but there was considerable stiffness in the right hip. Motion was restricted in all directions, there being practically no movement in the lumbar region, while a slight flexion was possible in the dorsal region. Lateral motion to the left appeared more painful than to the right.

*X-ray Examination.*—Negatives gave evidence of chronic arthritis involving particularly the fifth lumbar vertebra. The transverse process of the vertebra had been destroyed.

*Treatment.*—The patient was strapped but no relief was afforded. A plaster cast was then applied and worn by the patient for four months. He was then fitted with a spring brace which has become of daily necessity. No focus of infection could be isolated.

*Results.*—The patient has remained up to the present time incapacitated for all forms of ordinary work and has been receiving $16 per week compensation, which has amounted to approximately $1,700. It is expected that a lump sum settlement will be advanced. The patient, however, will always be a dangerous risk both to himself and to his employer.

## Summary

These cases illustrate the need of particular care by industrial physicians in examining the backs of all employees. Infectious arthritis of the spine is exceedingly expensive both to the employer and to the employee, and is a baffling problem to the industrial physician.

Many times, trivial accidents involving the back are treated as muscular strains, which would be the natural diagnosis from superficial examination. In order to arrest early the more serious disorder of infectious arthritis it is good practice to X-ray all cases where there is the least suspicion. It is possible that the X-ray may be negative even though the patient exhibits the unmistakable signs of local tenderness and rigidity. Reliance upon the X-ray in the majority of cases, therefore, demands positive evidence.

Prompt detection is of assistance in locating any foci of infection, as it permits the application of corrective measures which will improve the patient's general condition.

From every angle, the desirability of better control of infectious arthritis of the spine is manifest. Upon the physical examination at the time of hiring workmen rests the responsibility for the exclusion from employment of serious risks of this nature. Particular attention must, therefore, be directed to the condition of the joints; flexion of the trunk and limbs must be required, and other tests must be applied to bring out any signs of infectious arthritis. When there is reason for suspicion, examination should be carried further by means of the X-ray.

The duty of the industrial physician, in a word, requires:

1. More attention to the condition of the joints at the time of entrance examination;

2. Prompt and exhaustive analysis of back strain to detect immediately cases of infectious arthritis;

3. Prompt treatment to the focus of infection in an endeavor to eradicate it, and adequate treatment to the diseased area.

The effects of this disease are sufficient to warrant these precautions.

# SOME OBSERVATIONS ON THE EPINEPHRIN HYDROCHLORIDE TEST (GOETSCH TEST) IN A GROUP OF NORMAL INDIVIDUALS*

William P. Van Wagenen

TO Dr. Emil Goetsch we are indebted for the correlation and practical application of the physiological observations of Oswald (1) and Levy (2) that an increase in the active principle of the thyroid gland enhances the pressor action of epinephrin. The principle of the original observations of this writer has been substantiated many times. From time to time, however, there have been reported variations in the percentage of positivity of this test in cases of clinical hyperthyroidism. The doubts of Dr. Martin B. Tinker, of Ithaca, New York, regarding the validity of the observation that all cases of clinical hyperthyroidism give a positive epinephrin hydrochloride test — very severe and long standing cases excepted—led me to undertake to verify this observation on some sixty of his cases of hyperthyroidism, clinically so diagnosed, in the Ithaca City Hospital. There were two cases which, to the best of my interpretation, gave a negative result with this test. Reference to six similar cases of Peabody's will be made later. In the same series there were four cases concerning which there was a good deal of doubt as to the diagnosis of hyperthyroidism. History, physical findings, and the therapeutic test of rest in bed were all negative; unfortunately, basal metabolism determinations could not be obtained. The epinephrin hydrochloride test, however, was positive.

An experience of this sort is not unique. Woodbury (3) reports eleven patients who reacted positively to the epinephrin hydrochloride test but who had basal metabolisms considered to be within normal limits. They did not show any improvement of clinical symptoms on rest. The histories and clinical symptoms, however, were typical of hyperthyroidism and the cases were diagnosed as hyperthyroidism, in spite of normal basal metabolisms and the result of rest, because of the clinical pictures and histories, the histological examination of the glands and the post-operative results. While the diagnosis in Woodbury's cases is doubtless correct because of the recent increase in the size of the goiter, the nervousness, tremor, dyspnea, palpitation, and loss of strength, I question a diagnosis of hyperthyroidism on the basis of an increase in the height and size of active cells, with infolding of walls of the acini and a decrease of colloid. Goetsch (4) states that in about 20 per cent. of a series of his cases diagnosed as hyperthyroidism the pathologist failed to associate the histological findings with the clinical course of the disease. Likewise, a post-operative condition at a period of from six weeks to eight months after operation is not necessarily the final condition. A year is probably none too short a time in which to judge the lasting results of many cases of hyperthyroidism that come to operation.

Such observations as these of Woodbury's and my own led me to speculate on what percentage of normal individuals would react to the epinephrin hydrochloride test. Normal subjects for study with the Goetsch test were selected from Cornell University Sum-

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mer School students in the Department of Physical Education. A careful history was obtained from each student as to the possible existence of symptoms that a borderline hyperthyroid patient might show, fatigability, weakness, tachycardia, nervousness, loss of weight, etc., and the records of physical examinations of these students were consulted. A more physically fit, more symptomless group could not have been desired. So far as gross inspection showed, there were no cases of chorea, asthma, epilepsy, diabetes or dementia praecox which might account for a positive epinephrin hydrochloride reaction—an occasional occurrence, according to Peabody and his associates (5), in these conditions. Goetsch (6) adds to this list neurocirculatory asthenia. The differentiation of neurocirculatory asthenia from hyperthyroid states he makes on a family history of nervous instability and a slow gradual onset of symptoms, usually dating back before puberty, which the patient does not know he possesses. There was likewise no history of symptoms among this group that led me to suspect such a condition existed. A basis of this sort for ruling out neurocirculatory asthenia is obviously open to question.

In doing the tests, patients were required to lie quietly until the pulse rate, blood pressure reading and respirations were constant for at least fifteen minutes. Parke, Davis adrenalin hydrochloride was used. The potency of the drug was determined by injecting it intravenously into a cat and recording the blood pressure changes in the carotid artery; also by using the sample on known hyperthyroid patients with positive results. As soon as the patient was quiet and accustomed to his environment, an injection of 0.5 c.c. of adrenalin hydrochloride was given in the deltoid region. In fat individuals care was taken to make the injection as superficial as possible, since injection into the fat tended to obscure the local reaction or retard its appearance. Blood pressure readings were taken from the other arm every five minutes for one hour, together with pulse and respiration rates. Respiration varied so little that it is not included in the curves of other data.

The question of interpretation of results at once presents itself. Goetsch (4) considers a positive reaction to consist of a rise in pulse rate of at least ten beats per minute, and a rise in blood pressure of from 10-50 mm. Hg, together with a train of general symptoms and a local reaction to the drug. The general symptoms, as I found them, are in part objective, and in part subjective—*i.e.*, tremor of the platysma group of muscles of the hands and lower extremities, lachrymation, pallor of the mucous membranes and face, a feeling of weakness, tiredness, drowsiness, palpitation of the heart, throbbing of the aorta and neck and head vessels, a sense of constriction of the chest, white specks before the eyes and sometimes blurring of vision, and occasionally diuresis and urgency. When positive, Goetsch (7) considers such results to be practically diagnostic of hyperthyroidism. To quote from him:

> My epinephrine test depends upon the fact that in an organism in which there is an overamount of thyroid secretion present the sympathetic nervous system is sensitized to the action of epinephrine, and I have found after a study of over six hundred cases of thyroid disease that in clinical states of hyperthyroidism the patient reacts positively to the subcutaneous injection of 0.5 c.c. of one in one thousand adrenalin chloride solution, a dose to which a normal individual does not react.

From a practical point of view, Goetsch considers the test of considerable value:

A positive test has helped me in determining whether the case is truly hyperthyroid and whether thyroidectomy should be done, or whether continuance of medical measures should be advised, and it is this positive test which has helped me so much in the fourth group, which I have termed diffuse adenomatosis and which before had been so baffling. I have advised operation also in the adenoma group in which the adenomata were too small to be seen or felt before operation . . . and have had splendid results from resection as has been shown in the post-operative study of these cases.

Goetsch (7) claims further that a negative test excludes hyperthyroidism except in a few very severe cases.

Peabody, Sturgis, Tompkins, and Wearn (5) make the pertinent suggestion that "a theoretically 'positive' reaction might indicate hyperactivity of the thyroid gland, of the adrenal glands or of the sympathetic nervous system. It might, on the other hand, depend on a lowered threshold of response of the sympathetic nervous system. With the exception of hyperthyroidism little is known of these conditions in man, but they probably occur and there would seem to be no reason for assuming that a 'positive' epinephrin reaction is constantly associated with hyperthyroidism." Their observations in instances of this will be referred to again later.

In interpreting my own results I have not considered as positive a test that did not show a rise in blood pressure and pulse rate of at least fifteen points, together with well-marked general symptoms. My experience with the local reaction in cases of known hyperthyroidism varies. In a positive local reaction there is a blanching of the skin over the epinephrin injection in about five to fifteen minutes, which persists from sixty to ninety minutes or longer. The blanched area is surrounded by a narrow zone of purple, or red or blue, presumably due to venous dilation. This outer zone varies a good deal in color from individual to individual and also in the same person. I am inclined to believe that a changeability of color of this outer zone is seen in the majority of cases of true hyperthyroidism, and is occasionally seen in normal cases giving positive tests.

In the fifty cases composing this series there were ten positive reactions, or 20 per cent. The criterion of a positive test, as mentioned previously, was the change in blood pressure, pulse rate and general symptoms, and the local reaction. The average blood pressure and pulse changes were as follows:

*a.* The average maximum blood pressure rise for the ten positive cases was 16 mm. (Fig. 1); for the forty negative cases, 9 mm. (Fig. 2); for the combined group, 10 mm. (Fig. 3).

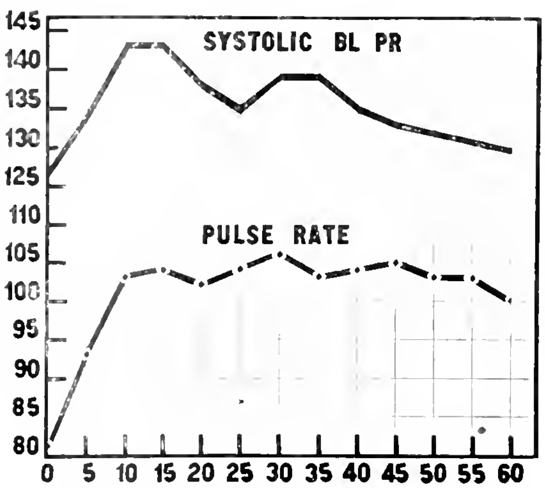


FIG. 1. Composite curves of ten positive reactions to the epinephrin hydrochloride test among a series of fifty normals. Ordinates in these figures represent millimeters of mercury for blood pressure and pulse beats per minute. Abscissas represent minutes.

*b.* The average maximum pulse rate rise for the ten positive cases was 25 beats per minute (Fig. 1); for the forty negative cases, 13 beats per minute (Fig. 2); for the fifty cases (combined), 16 beats per minute (Fig. 3).

Inspection of the figures shows that

the maximum and minimum blood pressure rises were, for the positive cases, 38 mm. Hg and 12 mm. Hg in Cases 22 and 25, respectively. The pulse rate curves show a maximum and minimum rise, for positive reactions, of 68 beats per minute and 26 beats per minute in Cases 18 and 32, respectively. In the forty negative cases the minimum rise was 5 mm. Hg in Cases 5, 6, 24, and 31; the maximum rise, 40 mm. Hg in Case 3. The minimum pulse rate rises were 5 in Case 16, and 38 in Case 25.

An instructive fact to note is that the starting point in blood pressure readings and also in pulse rate for both positive and negative cases was essentially the same, *i.e.*, 127 mm. Hg in positive cases; 121 mm. Hg in negative cases; 81 beats per minute in positive cases; 80 beats per minute in negative cases. It cannot, therefore, be assumed that the positive cases primarily had tachycardia with heightened blood pressure as they might have in hyperthyroidism, either obscure or evident on clinical examination.

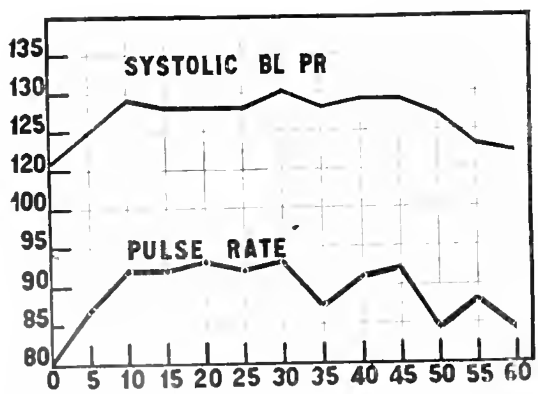


FIG. 2. Composite curves of forty negative reactions to the epinephrin hydrochloride test.

Inspection of Figures 1 and 2 shows that the first maximum blood pressure rise in both positive and negative cases occurred approximately at the fifteen minute period. Likewise the secondary rises occurred together—at the thirty-five to forty-five minute periods. Both of these curves are essentially typical of the curve seen in animal experimentation when epinephrin is injected intravenously. The difference is quantitative only.

An admitted fault in the procedure is the failure to continue observations on each case for at least two hours, instead of one hour. It is instructive, however,

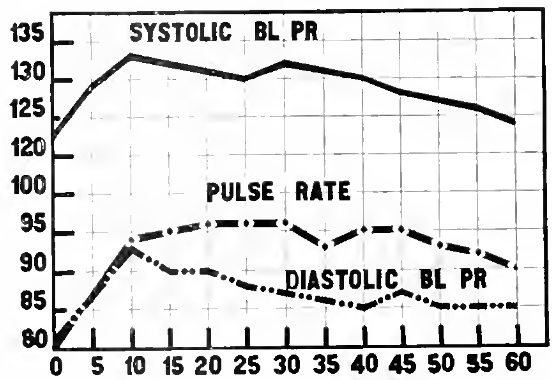


FIG. 3.—Composite curves of fifty reactions to the epinephrin hydrochloride test.

to note that the curve of blood pressure readings is as nearly back to normal in the positive cases at the end of an hour as in the negative cases. Had the curves of the two groups differed essentially in type, one might not expect this to be the case.

The pulse rate curves offer more difficulty of interpretation. In general, it may be said that in the positive cases the pulse rate rose to a maximum, or nearly so, in ten minutes, and was sustained at that level, with slight fluctuations, for the entire hour, having fallen but 6 points from the maximum in the sixty minutes. In the negative cases the pulse rate was more nearly back to normal, *i. e.*, within 8 points of the original. Figure 3 was made to show that the whole series of cases taken together—positive cases plus negative cases—gives a curve essentially of the same type as those shown in Figures 1 and 2, and similar to the curve of cases of known hyperthyroid reaction.

If one cannot combine pulse rate and blood pressure findings with general symptoms, I believe that the general symptoms are more valuable in determining a reaction. Tremulousness, beginning in the platysma group of muscles and also present in the hands and lower extremities, was the most constant symptom in my series, being present in all ten of the positive cases. A feeling of general weakness and tiredness was next in order of constancy, being absent in only one case. Seven patients complained of bladder urgency. There is, throbbing in the vessels of the head, neck and aorta. Lachrymation was present in three cases. One patient complained of bladder urgency. There is, of course, no means of quantitating general symptoms, especially subjective symptoms, except by their duration. In general, the positive cases gave symptoms lasting from thirty minutes to forty-eight hours—one case each—with an average of two hours. The negative cases, on the average, gave symptoms lasting from ten to thirty minutes. The severity of the general symptoms in negative cases, where any occurred, was always less than in the positive cases.

The local reaction was a distinct positive in four of the positive cases and in four of the negative cases; the blanching of the overlying skin occurred almost at once, the contraction of the erector pili muscles was prolonged over one hour and the peripheral zone of colors was variable, such as is seen many times in known hyperthyroid reactions. This feature of the test was the least satisfactory of any. With little subcutaneous fat and a coarse skin it works very well, but where the epinephrin is injected into the fat the results are more variable.

From the foregoing observations, admittedly small in number but done with great care, I am forced to express doubt regarding the diagnostic value of a test for hyperthyroidism in a "borderline case"—a test which is positive in 20 per cent. of a group of well, healthy, active, physical education students free from hyperthyroidism so far as history, symptoms and observation could determine; likewise free from psychoneuroses, neurasthenia, hysteria, and melancholia.

Peabody, Sturgis, Tompkins and Wearn (5), working among soldiers in camp, likewise present evidence which varies with the statement that no cases of hyperthyroidism fail to give a positive reaction, very severe and long standing cases excepted. In a series of twenty-one cases diagnosed as hyperthyroidism on the classic signs, symptoms and history, together with the determination of the basal metabolism, "six unquestionable cases, four in early stages and two in later stages with basal metabolism ranging between 21 and 35 per cent. above normal, gave negative reactions." Two such cases I myself have observed and have already referred to. Peabody and his collaborators find further that persons whom they consider as normal sometimes react positively to the test. Fourteen per cent. of a series of twenty-eight medical students gave positive reactions, and 17 per cent. of a series of seventeen cases of organic heart disease also responded positively to the test. These percentages accord fairly well with my own. Among 143 cases of "effort syndrome" also studied by Peabody and his collaborators 48 per cent. reacted to the test.

## Summary

1. In determining a positive reaction to the epinephrin hydrochloride test the

results must be considered as a whole, but the importance of the findings may be grouped in the following order: general objective and subjective symptoms, pulse rate curve, the blood pressure curve, and, lastly, local reaction.

2. The curves for blood pressure are essentially of the same type in negative cases, in positive cases among normal subjects, and in known hyperthyroid cases, differing only in a quantitative way. The general symptoms, likewise, differ only in quantity in these various types of cases.

3. The 20 per cent. of this series of cases which reacted positively to the test make it seem unlikely that the test can always be relied upon in cases where clinical observation is unable to establish a diagnosis of hyperthyroidism.

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# LIGHTING AND VENTILATION OF FACTORIES, HOURS OF LABOR AND HEALTH*

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My experience in Tasmania as the first Chief Inspector of Factories in that state served only to confirm my previous experience so far as realizing that the average employer and employee are but little concerned with questions of health and sanitation.

I found that, on the part of the employer, there was much concern lest the introduction of wages boards and the payment of wages more on a par with those paid on the mainland would cripple industry, whereas, on the part of the employee, the chief points of interest were the securing of better wages and a reduction of hours of employment. Time and again it was pointed out — often, unfortunately, with truth — that attempts to improve the conditions under which men and women worked in factories were looked upon by them with mistrust or were actually resented as an unwarranted interference. One would find that ventilators would be blocked, sanitary conveniences fouled, and, generally, that the workers were content with the old order, or disorder, with regard to sanitation.

The War has, however, altered the outlook as far as the biggest and best employers are concerned. It is being realized more and more that the health of the worker is a factor of vital importance in maintaining energy, without which output readily decreases. To maintain health man requires fresh air, a good and plentiful water supply, sufficient food and clothing, adequate shelter, and, above all, conditions of cleanliness, with adequate periods for exercise and recreation.

## Lighting

In recent years much attention has been devoted to the provision of proper lighting in factories. Sunlight is not only essential to the maintenance of health, but is the only perfect light. Diffused daylight is, therefore, always to be recognized as the standard light. Generally speaking, however, it cannot be claimed that hitherto sufficient advantage has been taken to secure the benefits of diffused daylight and, indeed, the dead hand of the past seems still to limit window space. In remote times, before the discovery of glass, and later before its universal use, openings for light were restricted, while in still later times there was actually a window tax, which naturally discouraged the provision of adequate lighting.

In Australia, as is true in most of the newer countries, we have followed the conventional styles of architecture which obtained in Europe, all too oblivious as to their adaptability or suitability to the climate. Any departure from the conventional or traditional styles appears up to recent times to have been regarded with the suspicion of either being eccentric or not complying with the traditional so-called artistic taste.

We find that in ordinary dwellings as well as in factories there is often no attempt to adapt window space to the lighting requirement of the particular room. One sees uniform sized windows fixed in

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dwellings where exterior obstructions interfere with the natural lighting, just as in dwellings where there are no obstructions. Moreover, there is often a failure to recognize the fact that even where there are no obstructions, the aspect and consequent natural lighting possibilities vary with the points of the compass. It is evident that the fixed rule as to the direct proportion between window space and floor space, such as 1/10 or 1/5, should only be taken as a minimum, and that such important factors as the nature of possible exterior obstruction, position of windows (vertical or horizontal), length and width of room, and angle of incidence of sunlight must be given due consideration. Otherwise, defective lighting will inevitably result.

The most effective natural light is obtained from a high window with splayed jambs, extending nearly to the ceiling, and situated near the center of the wall. It is impossible to get too much natural light, and it is noticeable that this fact has been recognized by the leading jewelry firms of Sydney, whose large workrooms, recently built, have practically one continuous window on each side. The best lighting effect in factories, especially in those of one story, is obtained from skylights, provided the roof is from 30 to 35 feet high. With roofs less high the glare from the direct rays of the sun and the intense heat of summer make this method unsuitable.

The modern tendency in cities to crowd high buildings on a limited space has necessitated considerable ingenuity in the provision of light areas. Even where these areas are painted white in order that every advantage may be taken of them, it is often necessary to resort to artificial lighting, which can never be considered a completely efficient substitute for daylight, and which is only justifiable when daylight fails, or under exceptional circumstances. I do not propose here, however, to discuss the relative merits of the various forms of artificial lighting. Certainly, as far as Hobart is concerned, with her splendid hydro-electric works and comparatively cheap power, electric lighting ought to hold the field.

From the fact that sunlight is the most satisfactory, the nearer we approach in artificial illumination to the reproduction of such diffuse white light, the better. We can, however, formulate the following essentials in lighting: a sufficiency of white light without excess; perfect steadiness; effective diffusion; freedom from violent contrasts; downward and preferably oblique direction. The source of light, which is usually the cause of trouble, should not be in a direct line with the eye, and in the case of brilliant lights it is important to have diffusion globes or other means of softening the glare. It is quite essential, too, that the light be steady; otherwise the eye is irritated by continuous and ineffective attempts at accommodation. Direct sunlight effects may be reduced by the use of blinds or, in factories and workshops, particularly, the light may be diffused by means of windows of ground or prismatic glass.

Sunlight is absolutely essential to the maintenance of health. Most people are familiar with the anaemic appearance, the limited vitality and the susceptibility to disease of those who habitually live or work under darkened conditions. Recently, in Sydney, I found an elderly woman and a child who had been living under conditions where they never got direct sunlight, and who consequently were blanched and bleached like celery.

When uniform lighting is desired, one foot candle can be obtained from:

1. *Electric Lighting*
   - (*a*) Ordinary vacuum lamps 0.2 to 0.3 watt per square foot.
   - (*b*) Gas-filled (half-watt) lamps 0.1 to 0.15 watt per square foot.

2. *Gas Lighting*
   (*a*) Low pressure — 1 cubic foot per hour per 100 square feet illuminated.
   (*b*) High pressure — 1 cubic foot per hour per 200 to 300 square feet, according to pressure employed.

The above figures assume direct lighting with scientifically designed reflectors and appropriate spacing. In general, the consumption will have to be increased 50 per cent. for semi-direct, and 100 per cent. for indirect lighting, in order to obtain the same illumination on the working plane, though more light may be directed into the upper part of the room. All globes, shades, and reflectors should be cleaned at regular intervals, varying from one to six weeks.

In modern factories there is a tendency to adopt overhead lighting from units in which half-watt lamps are used, mounted direct on the ceiling or girders. In order to keep the light out of the direct range of the vision of the operators and to make possible the alteration of machines without change of illumination, the walls should be lime washed and the machines painted green or slate gray. It is now possible for modern firms actually to plan an efficient lighting scheme by paying attention to correct spacing and distribution, and, by specifying the consumption of electricity per square foot, to forecast with accuracy the illumination which will be produced on a working plane.

With indirect lighting the source is completely shaded, the rays being reflected on the ceiling, whence they are diffused throughout the room. An excellent effect is obtained in the lighting of the Lord Mayor's room at the "Mansion House," London, which was one of the first places in which this new method of lighting was introduced. This method eliminates glare, gives soft shadows, and at the same time causes light to penetrate to every corner of the room. It requires a higher degree of illumination, however, and is not suitable for factories where pillars or girders interfere with reflection from the ceiling.

Semi-direct lighting, where part of the total lighting is simply diffused by the bowl of the fitting which is made of opal glass or other translucent material, is now coming largely into vogue, and is the method most commonly used for lighting banks. A good illustration may be seen in the Commonwealth Bank of Sydney. But the effects of this system just as those of direct lighting are lost by dirty bulbs, grimy fittings, reflectors or ceilings. A hardly perceptible film of dust may reduce the effect of lighting by 20 per cent., and a several months' accumulation by 50 per cent.

From tables which have been compiled showing that 75 per cent. of the accidents in factories occur after 4 P.M., and that there is an increase of from 50 to 100 per cent. in the number of accidents during the winter, we may conclude that poor lighting is a contributory cause of accidents, in addition to being injurious to the health and eyesight of workers. Indeed, it is not generally recognized how much eyestrain and headache insufficient and unsuitable lighting causes, nor how prejudicial an effect it exercises on the quantity and the quality of work.

Proper supervision of work and maintenance of cleanliness and general sanitary conditions are only possible with efficient lighting. Statutory provisions requiring adequate and suitable lighting, by defining standards for factories and workshops, are needed for the employee as well as to insure a satisfactory quantity and quality of output of work for the employer. The United States, France, and Belgium are paying considerable attention to legislation with regard to these questions.

For general lighting, regulations such as the following should be adopted:

| | Foot Candle at Horizontal Plane of Floor Space |
|---|---|
| 1. Over working areas, without prejudice to that required for the work itself | 0.25 |
| 2. In all parts of foundries, where any person is liable ordinarily to pass | 0.40 |
| 3. In all parts of factories and workshops, where any person is liable ordinarily to pass, and not covered by recommendation (1) | 0.10 |
| 4. In all open places, one hour after sunset and before sunrise where persons are employed, and in any dangerous parts of the regular roads or approaches | 0.05 |

An important accessory to any method of lighting, if the maximum illumination is to be obtained therefrom, is the color effects in the room. It must be a brilliantly lighted room which can dispense with additional light given off by suitable reflecting surfaces. Light colored surfaces are essential to obtain full value for ordinary lighting, where circumstances are such that external or internal conditions interfere with the direct light from the window. In addition to white colored interiors, all obstructing outside surfaces should also be white. The walls of dry areas of basements should be sloped, whitened, and kept constantly clean.

We have found in Sydney that prismatic glass in windows, daylight reflectors, and even prism pavements serve a useful purpose. Borrowed light by means of door panels glazed with ground, prismatic, or other highly reflective glass, are now frequently used in offices and factories. Fanlights for darkened stairways are also useful and should never be obstructed by so-called ornamental glazed paper.

### Ventilation

In view of the research of recent years, the whole subject of ventilation has had to be recast. Discomfort with consequent ill health from lack of ventilation, or rather from absence of perflation, is due to the retention of the surplus heat of the body following an increase in the temperature and relative humidity and stagnation of the air. The change which renders air unfit for human beings is a diminished capacity for taking up heat, which is brought about by an increase in the temperature and in the amount of aqueous vapor in the air. It is necessary, therefore, to ventilate rooms, not because of the excess of carbon dioxide that is to be found where persons are confined in an enclosed space, not on account of the lack of oxygen, not primarily because of any mythical organic poison, but first of all to eliminate the superfluous heat from the bodies of the occupants. This has been definitely proved by recent investigations and experiments by Leonard Hill, Haldane, Flügge and others.

Paul, in Flügge's laboratory, shut himself in a glass cabinet and breathed the same air over and over again without discomfort for four hours when the temperature was not above 60° F. and the humidity not above 72 per cent. of saturation. When the temperature was raised to between 68° and 86° F. and the humidity to between 72 per cent. and 90 per cent., serious symptoms appeared in fifteen minutes. Paul measured the surface temperature of his body and found that, with this increase in the temperature of the air, the temperature of his body had increased. Discomfort was relieved when the hot air of the experimental chamber, otherwise unaltered, was set in movement with a fan.

Heat, moisture, and absence of movement in the air acting on the skin are conditions which have to be prevented in order to secure efficient ventilation. The air in an efficiently ventilated room, therefore, must have sufficient motion without causing a chilling draught, and requires constant change to prevent stagnation and over-heating. When the temperature is too high, we need more motion or a larger air supply to keep the body cool. When the temperature is too low, we need less motion or less supply of air to keep the

body warm. This is entirely a surface or skin function which makes the provision of ventilation a physical and not a chemical problem.

In certain industries dust is added to the air and mechanically irritates the breathing mechanism, as in quartz mining and file making. In other processes, lead, mercury, or the fumes of phosphorus affect the workers. Dust consisting of the débris from the wear and tear of articles in use, products of combustion, particles from the skin and from the streets, all add to the impurity of the air of houses and factories. Thanks to wind, rain, and sun, however, the atmosphere in our towns is constantly being purified.

The air of a room or factory, to be satisfactory, must be in a state of constant movement, must be cool, free from disease germs and dust and, above all, must possess a proper degree of relative humidity. When the temperature of the wet bulb thermometer reaches 78° F., continuous work becomes impracticable, and at 88° F. it becomes impossible. The conversion of the indications of the wet and dry bulb thermometer into the mere percentage of humidity which might be comfortable at 60° or 70° would be horribly oppressive at 80° or 90°, and fatal at 100°. On the other hand, at 30° or 40° such a humidity would make conditions intolerably chilly.

Dr. J. S. Haldane relied on the wet bulb readings alone and proposed 70° F. wet bulb as the desirable maximum, and 75° as the temperature which should not be exceeded. Although this is a more satisfactory criterion than the recording of the percentage of saturation, a still more satisfactory method is that introduced by Mr. John L. Bruce of Sydney. Mr. Bruce found that while a wet bulb temperature of 70° or 75° is not oppressive when the dry bulb is 80° or 90°, yet when the air is fully saturated and there is no evaporation — that is to say, when the dry and wet bulb temperatures are identical — a temperature of 70° is very oppressive, and a temperature of 75° almost unendurable, most muggy and oppressive.

Mr. Bruce found that a wet and dry bulb thermometer based upon a constant dew point gave comfortable and desirable conditions at all dry bulb temperatures in New South Wales. So long as the dew point did not rise much above 62° F. the conditions were not unpleasant. Even with a very high dry bulb temperature, bodily vigor was not impaired. With a dry bulb of 111° and a wet bulb of 82°, but with the dew point only 66°, hard work was done without discomfort, although the air was burning hot; whereas with a dry bulb of only 77° and a wet bulb of 75°, but with the dew point 73.5°, the conditions were depressing.

The table of permissible dry and wet bulb temperatures in the New South Wales Factories Act of 1909, as fixed by Mr. Bruce, was based upon a minimum dew point of 57° and a maximum of 67°. This gives a mean dew point of 62° F., at which temperature saturated air is neither muggy nor chilly. When the dew point is from 70° to 75°, exertion becomes difficult, but with the dew point near 62°, even with high wet and dry bulb temperatures, work can be carried on without inconvenience.

Mr. Bruce's records show that the comfortable and invigorating conditions of temperature in relation to moisture in the air are indicated by the dew point rather than by any mere indication of the wet bulb or of the dry bulb alone. By lines drawn from the dry bulb thermometer scale to the wet bulb scale, in such a way that when the mercury in the dry and wet bulb thermometers is at the level of the corresponding ends of the line, a dew point of 62° is indicated on an instrument designed by Mr. Bruce and made by Mr. Esdaile, Hunter St., Sydney. By this instrument the ordinary individual can re-

cord comfortable conditions of temperature and moisture, and can regulate mechanical ventilation in certain industries and factories in accordance therewith.

The Factories Act requires that in every factory in New South Wales the means of ventilation, warming and cooling, to be provided and maintained, shall be such as to keep the humidity and temperature of the air during working hours within the proportions of temperature in relation to moisture shown in Table 1. The relative maximum temperatures of the wet bulb thermometer must never be exceeded within the factory or shop except when the humidity in the fresh open air surrounding the factory or shop is so excessive that it shows an increase in those relative temperatures. On such occasions the wet bulb temperature within the factory may be increased in the same proportion as that shown by the open air. If for any special manufacturing process or storage purpose any occupier desires the air in his factory workshop to be saturated with moisture beyond the proportions shown by the relative temperatures given in Table 1, he must make written application to the Minister for special permission to do so, specifying the conditions as to temperature and moisture which he desires.

TABLE 1.—RELATIVE DRY AND WET BULB TEMPERATURES REQUIRED BY THE NEW SOUTH WALES FACTORIES ACT

| Dry Bulb Thermometer Showing Air Temperature in Degrees Fahrenheit | Corresponding Wet Bulb Thermometer Showing Humidity in Air | |
|---|---|---|
| | Minimum Fahrenheit | Maximum Fahrenheit |
| 40 | 35 | 37 |
| 50 | 44 | 47 |
| 60 | 53 | 53 |
| 65 | 60 | 61 |
| 70 | 63 | 68 |
| 72 | 64 | 69 |
| 75 | 65 | 70 |
| 80 | 67 | 73 |
| 85 | 68 | 73½ |
| 90 | 69½ | 74 |
| 95 | 71 | 75 |
| 100 | 73 | 76 |
| 105 | 74 | 77½ |
| 110 | 75 | 78½ |
| 115 | 76½ | 80 |
| 120 | 77½ | 81 |

The only case of exemption under the Factories Act in New South Wales, in which the relative maximum temperature of the wet bulb thermometer is permitted to be exceeded, is in a large tobacco factory. This factory, one of the most up-to-date in Australia, with a large amount of window space, requires for manufacturing purposes an even, moist temperature. In hot weather, when northwest winds prevail, windows can be freely opened, but when the dry, westerly winds are blowing, the means of ventilation cannot be fully utilized, as the leaf becomes too dry to handle readily. Readings taken by Miss Harriott, Senior Inspector, with a wet and dry bulb thermometer, showed that the humidity of the atmosphere in the "rolling" department slightly exceeded that allowed by the Factories Act. I was therefore called in to investigate, and at my recommendation a certificate was given permitting the company to vary the temperature of the wet bulb in the "rolling" department, so long as it did not exceed by more than 3° the temperature indicated in the regulation. This company is probably the best exponent of welfare work among employees, in New South Wales, and only avails itself of the concession when exceptional weather conditions render it necessary.

For natural ventilation the rule is generally laid down that openings for the exit of foul air should average 24 square inches for each individual. Where the openings for fresh air are larger than those for the exit of foul air, and are placed 5 or 6 feet from the floor, possibilities of draught are minimized. Hitherto, sufficient use has not been made of the natural ventilation obtained by leaving a space between the upper portion of the wall and the roof of buildings. It is a good rule, in factories, to

invest one person with the responsibility of seeing that windows are kept open and of prohibiting the closing of windows except to prevent rain or dust from driving into the room. With this proviso, in most cases natural ventilation should be sufficient, except on days with relatively high humidity, when it is necessary to supplement it by mechanical movement of the atmosphere, as by electric fans.

The difficulty of ventilating factories, largely due to the accumulation of pockets of foul air, especially toward the center of large rooms, can only be entirely satisfactorily removed by mechanical means, the best of which appears to be a combination of the plenum and vacuum systems. Where there is special risk from dust, fumes, or gases, owing to the nature of the employment, strong exhausts and hoods are necessary at the points of production.

Modern factory managers who have studied the recent investigations of the Munitions Health Committee must realize that the better the ventilation the better the health of the employees and the better the work performed.

## Hours of Labor and Health

A remarkable feature of the earlier years of the War, when it was necessary in England to concentrate on the organization of munition works, was that for a time, by mutual agreement of employers and employees, the restrictions as to hours of work were withdrawn, and men, women, young persons, boys and girls, all worked at high pressure, the stimulus of national necessity being backed up by high remuneration. What was the result? It was found that such extensive concentration on work for long hours did not pay and that Sunday labor, that is, the lack of one day's rest in seven also did not pay.

Certain employers who kept a careful record found that output not only was not increased by the seven-day working week, but that it actually declined after the first few months. The six-day working week was then restored. It was found, however, that the considerable increase of overtime was telling on the workers, as evidenced by the amount of lost time from sickness. With improved management of the factories, it was soon realized that more work was actually done in an eight-hour day than in a ten-hour day.

The results of the investigation by the Scientific Research Committee appointed to review the operations of munition workers, and the collection of data as to the occurrence of fatigue, showed that the output in certain industries followed the same curve as that of a muscle stimulated by a galvanic current. It was found that, just as nature observes rhythm and prescribes periods of rest, so, in order to obtain maximum efficiency in industry, it is necessary to observe as closely as possible the prevention of excessive fatigue beyond the point recoverable by a reasonable period of rest. The old adage of "all work and no play makes Jack a dull boy" was again exemplified in industry. It was found that in mechanical industries the output increased at a certain period of the day and then declined; then increased again, after an interval for a meal, then declined; and, in some industries, then increased for the last hour in an eight-hour day, but in a ten-hour day steadily declined. Another interesting point noted was that where there was machinery the incidence of accidents increased as the period of fatigue was reached.

The Industrial Fatigue Committee of the United States Council of National Defence, after an elaborate investigation by the Division of Scientific Research of the Public Health Service to discover in munitions factories the conditions under which a maximum continuous output might be obtained, discovered that while it is often

possible to increase output temporarily by increasing the work of the employee, if he be overworked, the output soon falls off. Such a method quickly defeats itself and is not profitable in the long run. Given adequate equipment and administration of the plant with a proper spirit among employees, fatigue was found to be the greatest single obstacle to a maximum output. Fatigue diminishes output both directly and also indirectly by increasing accidents, sickness and the proportion of spoiled work.

In addition to the mere recording of a falling off of output per individual per hour, day, or week — according to the duration of the working period — the comparing of averages per hour under different schedules of work, and the estimating of the fall in the amount of electrical or other power consumed due to other causes than temporary stoppage, of the amount of spoiled work, and of the number of absences from accidents and sickness, various tests of fatigue were supplied by investigators in the laboratory and applied to industries. These tests concern the muscles, the nervous system, sight, hearing, and certain chemical changes within the body. Consideration was also given to the living conditions of the workers and to their habits as to recreation outside the factories, although fatigue due to outside conditions is obviously less easily controlled than that caused by work inside the factory.

The introduction of obligatory resting periods during a working spell is well illustrated in Australian Shearing Sheds by the "Smoke O." You must have often read during the War that so and so did exceptional service for a continuous period under heavy fire, etc., for forty-eight or seventy-two hours. With regard to stretcher bearers, one read of men being continuously on duty for days during a heavy engagement. My experience was that such overwork did not pay as the men speedily became fatigued. Therefore, when I was put in charge of the evacuation of wounded of the Third Australian Division for the Battle of Messines, and had to plan for the removal of the wounded from four Regimental Aid Posts, I made arrangements to work in shifts the 308 stretcher bearers of the ninth, tenth, and eleventh Field Ambulances who were at my disposal. I insisted on half the men resting for the first twelve hours after zero, the moment of attack. Consequently, after twelve hours of strenuous work we had a fresh group of men to carry on. Then, after the second twelve hours, those not casualties in the first group were able to carry on, and in this way we managed to keep up the work for six days and nights.

It was also found during the War that a five minutes' halt for a breathing spell at the end of each hour of marching was an advantage for both man and beast.

It was the experience in American factories, likewise, that five-minute resting periods in a working spell, or, where this was not possible, a single recess of ten or fifteen minutes' duration, increased the output, especially if a cup of cocoa or milk was served to the worker. The resulting increased efficiency yielded equal, if not greater output.

The introduction of variety into work also diminishes fatigue. Anyone who has seen a girl labelling tins, wrapping up soap, or performing some other mechanical work, can realize that if she were trained to do some alternative process so that she could temporarily interchange work with another girl, fatigue could be diminished without lessening output.

*Adjusting the Speed.* When a single motor operates a number of machines the speed may more easily be adjusted to the average pace if an exceptionally fast or slow worker is transferred to another job, in order that the same rhythm may be secured throughout the squad. Fatigue is least when the customary rhythm is main-

tained, and the output may be twice as great as when the speed is a little slower or a little faster than this customary rhythm. It was noticeable in Lever Bros. works at Balmain, Sydney, that the incentive of piece rates in certain branches kept up a high rate of output.

*Omitting Unnecessary Motion.*—It was also noticeable at Lever's works that the placing of the packages, which the workers had to handle, at a convenient height and distance from their hands prevented unrhythmical, unnecessary motions or undue muscular exertion, and thus caused the work to be done automatically with the least possible waste of energy and time.

*Alternating Day and Night Work.*—The British Health of Munition Workers' Committee, after a careful statistical study of output, found that where the same night shift continued in employment the total output was less than where there was an alternation of day and night work. This was true of both men and women. The alternating periods of night work should not, however, be less than one month in duration, as frequent changes of habit might be deleterious to health.

With regard to the workers in the cleansing department of the Sydney City Council we find that it is advisable periodically to change men on the night shift to day work and *vice versa* as a means of keeping down loss through sickness, especially neurasthenia, gastritis, and bronchitis.

*Adjusting Hours of Work.*—The British Health of Munition Workers' Committee found that it was a mistake to recommend a uniform day for all kinds of work. The most profitable duration of the working period for women and boys, even when employed on shift work, was found to be less than for men. It is obvious that a man can do more work in two hours than in one hour, but it does not necessarily follow that he can do more work in twelve hours than in ten hours, or more in ten hours than in eight hours, or in some arduous occupations, more in eight hours than in six hours, over a lengthened period. Whenever the work is of such duration as to cause pronounced fatigue, it has been shown again and again that after some time shortening the working period actually increases the amount of work done.

A granite-cutting company found that "the same man under identically the same conditions accomplished more of exactly the same kind of work when he was working nine hours than he did when he was working ten hours. And again, when the hours were reduced to eight hours, this same man accomplished still more in an eight-hour day than he did in a nine-hour day, or a considerable amount more than he did when the day was ten hours long."

In one English munition factory the average weekly hours of men sizing fuse bodies were reduced from 58.2 to 51.2 with a total increase of output of 21 per cent. Another munition factory—one of the largest in England during the War, employing 70,000 workers—gave its employees a whole holiday on Saturday instead of a half day, owing to numerous absences from work. As a result, the absences were diminished by 50 per cent., and consequently the firm has continued the custom.

Although the abolition of Saturday work among the 3,000 employees of the Sydney City Council is only a recent venture, it is an interesting fact that never have I had so few men reporting sick as during the last eight weeks. Thus, the saving in money in paying men during absence from sickness, as is the practice of the Sydney City Council, may in the end pay for this innovation which is so much appreciated by both the indoor and outdoor workers. The fact that a man knows that he has two days' leisure at the end of the week often makes him remain at his job until Friday; moreover, for the same reason, men now come up on Friday to sign on again to start

work on the following Monday instead of waiting until 9 o'clock on Monday morning for medical examination, which would generally mean that they could not start work until Tuesday.

*Avoiding Overtime.*—If the usual day's work stops just short of undue fatigue, overtime means overwork. Overtime work is apt to result in an increased amount of spoiled work and in lessened output, as well as in an increased number of absences on subsequent days, and is, consequently, unprofitable, particularly in view of the increased rate of wages that must be paid.

It has been very noticeable to me, especially in the Electric Lighting Department of the Sydney City Council, where, owing to certain circumstances, it has been necessary for men to work considerable amounts of overtime and in some cases to do double shifts, that we have had a number of cases of neurasthenia and gastritis, especially in the summer months. In some cases men were absent through sickness, largely the result of over-fatigue, treble and quadruple the time they worked overtime. Overtime should only be resorted to in exceptional emergencies and even then not for many days in succession. Even in agricultural work, a tired worker who has not had time to recuperate cannot do himself or his employer justice.

# BOOK REVIEWS

INDUSTRIAL FATIGUE AND EFFICIENCY. By H. M. Vernon, M.A., M.D., Investigator for the Industrial Fatigue Research Board; Late Fellow of Magdalen College, Oxford. Cloth. Pp. 264 with index. London: George Routledge & Sons, Ltd.; New York: E. P. Dutton & Co., 1921.

This book constitutes a thorough discussion of our field knowledge of industrial fatigue. It is not concerned with laboratory material, but has been compiled with a thorough appreciation of the significance of laboratory results.

The opening chapter gives the author's conception of the problem. He accepts fatigue as the necessary result of work and considers that from the point of view of industrial hygiene one should search first of all for evidence as to whether the "fatigue induced by an industrial occupation has an unfavorable influence on the health of the worker." It is recognized that effects on health may take weeks, months or even years to appear, and that consequently the essential problem of industrial fatigue is most difficult. As a second and somewhat less important endeavor, search should be made for sources of "unnecessary fatigue." It is clearly unwise to add useless dissipation of energy to the routine of daily labor. Such a point of view has nothing to do with requiring an honest day's work. It simply means that every effort should be made to increase productivity through conservation of unnecessary labor.

The author regards it as highly improbable that any single test will ever give valid measurements of fatigue in diverse occupations and, as a consequence, comes to the conclusion that "the only satisfactory test at present available is one based on the performance of the operation itself."

In studying different operations the working capacity has been measured in terms of hourly, daily and weekly periods in many different industries and under varied hours of work, rest periods, etc. Chapters concerned with such data are followed by others upon lost time and its causation, the prevention of industrial accidents, and factory conditions. The introduction to the final chapter on practical conclusions sums up the attitude which in a general way governs the presentation of the material: "Up to a certain point fatigue is a natural physiological condition, which is inevitably incurred as the result of industrial work, and it does good rather than harm to the worker. Beyond this point it becomes pathological and acts injuriously upon him, but the pathological condition arises so gradually out of the physiological, and the evil effects produced at first may be so slight, that it is often quite impossible to put a finger on the line of demarcation. Often one can judge only by the cumulative effects of the over-fatigue, which may take weeks, months, or even years, to reveal themselves beyond question, and then it may be too late to effect a remedy. Hence the employer of labour who wishes to avoid all industrial conditions which injure the health of his employees, and the investigator who wishes to advise on the means of attaining this end, often have to act, or suggest action, on general principles. They may not be able to adduce specific reasons which can be substantiated by a direct appeal to the industry or occupation under consideration. . .Let the conditions suggested by a study of other industries be adopted. Some of them can be followed boldly and without question, whilst others, about which less certainty exists, should be pursued cautiously, in gradual stages. Let the effects of such changed conditions be carefully studied, not for a few weeks only but for many months, till definite conclusions can be drawn. That is to say, every substantial change in industrial conditions ought to be regarded as an experiment, the effects of which should be carefully ascertained, not only because of their immediate interest to the employer who has made them, but because they concern everyone who is in any way connected with the industry in question, and to a less extent those connected with other industries. The secret of progress in the science of industrial fatigue is the adoption of the *experimental method*, and the rate of progress depends very largely on the interest and co-operation of employers." This point of view has often been lacking both in the collection and presentation of data upon industrial fa-

tigue. The subject is so closely bound with economic and sociological questions as to cause investigators to look for certain things rather than to view the problem with the detachment it requires.

Dr. Vernon's book will serve as a useful text for all those who are teaching this subject to students of college and graduate grade. Many references are given, and indexing is fairly complete. A most commendable feature is found in the close proximity of charts and tables to the text discussing them. It is seldom that one finds a volume in which this desirable feature of successful printing is so well arranged.—*C. K. Drinker.*

## BOOKS RECEIVED

Books received are acknowledged in this column, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Public Health and Hygiene. In Contributions by Eminent Authorities. Edited by William Hallock Park, M.D., Professor of Bacteriology and Hygiene, University and Bellevue Hospital Medical College, and Director of the Bureau of Laboratories of the Department of Health, New York City. Cloth. Pp. 884, with illustrations and index. Philadelphia and New York: Lea & Febiger, 1920.

Essentials of Laboratory Diagnosis. Designed for Students and Practitioners. By Francis Ashley Faught, M.D., formerly Director of the Laboratory of the Department of Clinical Medicine and Assistant to the Professor of Clinical Medicine, Medico-Chirurgical College, etc., Philadelphia, Pa. Seventh Revised and Enlarged Edition. Cloth. Pp. 523, with illustrations and index. Philadelphia: F. A. Davis Company, 1921.

Ringworm and Its Successful Treatment. By John P. Turner, M.D., Medical Inspector of Public Schools, Philadelphia, Pa. Cloth. Pp. 62, with index, foreword, introduction and illustrations. Philadelphia: F. A. Davis Company, 1921.

ANNOUNCEMENT OF

# THE AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS

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One thousand members by May, 1922—this is the goal which the AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS has set for itself in its present membership campaign.

Can YOU as a physician afford not to be interested in INDUSTRIAL MEDICINE?

If you are holding an industrial position, however important, however small, you will get more out of it and put more into it if you belong to the AMERICAN ASSOCIATION OF INDUSTRIAL PHYSICIANS AND SURGEONS. This Association can serve you—

1. In the study and discussion of problems, national in scope, peculiar to the practice of industrial medicine and surgery.
2. To develop methods adapted to the conservation of health among workers in the industries.
3. To promote a more general understanding of the purposes and results of the medical care of employees.
4. To unite into one organization members of the medical profession specializing in industrial medicine and surgery for their mutual advancement in the practice of their profession.

MEMBERSHIP from now until the close of our fiscal year, May 1, 1923, will cost you only $6.00. Yearly dues are $5.00.

There are three classes of membership—Active, Associate, and Honorary.

*Active Members.* Physicians who are actively engaged part or full time in the practice of industrial medicine and surgery, or who are engaged in the investigation of industrial medical problems.

*Associate Members.* Physicians INTERESTED in industrial medicine. (Entitled to all the privileges of the Association except voting and holding office.)

*Honorary Members.* Persons who have contributed distinguished service to the objects for which the Association stands.

Membership entitles you to: (*a*) Our official journal, *The Nation's Health*, which contains full reports of all the affairs of the Association, together with other interesting articles on industrial medicine. (*b*) Bi-monthly abstracts of current industrial medical literature. (*c*) Reports and digests of interest to those engaged in industrial work.

REMEMBER THE DATE OF THE ANNUAL MEETING, MAY 22, 23, ST. LOUIS, MO.

(The same week as the A.M.A. Meeting.)

## CENSUS OF SAFETY AND HEALTH WORKERS

All industrial physicians and surgeons, industrial nurses, and other persons engaged in industrial health work are to be included in the census of safety and health workers now being taken by the National Safety Council in all parts of the country. Although health work in industry, along with safety, has made great strides in the past few years, it is not at present known how many persons are engaged in either of these activities, who they are, or where they are located. This is the first time an attempt has ever been made to list all the industrial safety and health workers. Public safety workers will also be included in the census.

It is believed that the results of the census will give a good indication of how extensive the safety and health activities now being carried on are. The census will include not only members and employees of members of the National Safety Council, but all persons engaged in industrial safety and health work whether connected with the Council in any way or not. The Council has almost as deep an interest in industrial health work as in accident prevention, and is very closely allied with the American Association of Industrial Physicians and Surgeons. Many health workers and companies employing health workers are numbered among the Council's membership.

Industry in general and the nation at large will profit from the results of this census. It will enable the Council to find quickly speakers on industrial and public safety for any occasion in any locality; authors for special articles on accident prevention; writers of safety text-books; lecturers on accident prevention and industrial health work for universities and colleges. The Council at present continually receives requests from industrial companies, municipalities, civic associations, clubs, schools, colleges, and other organizations for help in finding speakers or writers on safety subjects. The census records will greatly increase the facilities of the Council for filling such requests.

Every reader of this publication who is professionally engaged in industrial or public accident prevention or industrial health work — whether he is devoting all or only part of his time to accident prevention — is urged to assist in the taking of this census by sending to the National Safety Council, 168 North Michigan Avenue, Chicago, his name and the other data requested in the Council's census form, which follows:

Name ..............................................................................

Company or organization ..........................................................

City .................................................. State ..........................

Nature of company's business .....................................................

Is safety your principal work? ...................................................

Please check other activities you engage in:

| | |
|---|---|
| Fire protection | Engineering (other than safety) |
| Health and sanitation | Legal |
| Workmen's compensation and claims | Insurance |
| General executive (such as manager or superintendent | Welfare Educational |
| | Industrial relations |

How long have you been in your present position? ...............................

Technical or other special education? ............................................

Signed ..................................................

Title ..................................................

# THE JOURNAL OF INDUSTRIAL HYGIENE

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## ADEQUATE INDUSTRIAL MEDICAL SERVICE FOR THE SMALL PLANT*

CAREY P. McCORD, M.D.

AND

DOROTHY K. MINSTER

*Cincinnati, Ohio*

IN the usual industrial city, the aggregate of workers employed in small plants exceeds the number employed in the larger plants of 500 or more workers. In Hamilton County (the county in which Cincinnati is situated), there are, under normal industrial conditions, approximately 3,000 factories, of which number about 2,600 have less than 100 employees. Less than twenty of the county's factories employ 1,000 or more persons. Of the county's industrial population less than 5 per cent. receive adequate industrial health supervision. This is due largely to the high percentage of industries which are too small to warrant a full-time physician, and in which, consequently, medical work is usually limited to the care of emergencies. Such services are ordinarily obtained by sending the injured or sick person to find some neighborhood physician or, in extreme emergency, by calling in to the plant any available neighborhood physician. These physicians may be well qualified to take care of the medical or surgical condition but very obviously they do not serve the best interests of the patient as an employee or of the manufacturer, in that they are not industrial physicians, are not acquainted with trades processes and industrial health hazards, and their services, however excellent, only care for the unnecessary by-product of bad plant conditions.

It is common knowledge to the industrial physician and the industrial hygienist that the small plant proportionally harbors a far greater quantity and diversity of health and safety hazards than the large plant. Two examples now cited should be obvious and convincing. The plant of 500 employees is warranted in the installation of a water cooling system with automatic temperature control, with drinking fountains, suitably placed each to accommodate

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about thirty employees. The plant of seventy-five employees is, however, rarely justified in this considerable outlay and resorts to the use of various types of coolers—a practice which increases the probability of the common drinking cup, harmful low temperature of water, etc. In the large metal trades plants the hazard from cutting fluids may be reduced to a minimum by sterilization of the cutting compound and by the removal of metallic particles through centrifugalization or magnetization. In the small machine shop the hazard to the individual from cutting fluids is just as great, but the considerable expense entailed in such installation is usually regarded as excessive.

## Methods of Extending Medical Service to the Small Plant

Both the manufacturer and his employees share in the tremendous values derived from a factory medical department that regularly serves all employees in any sickness or injury, throws around them healthy work conditions, educates them in safety measures, and places them on jobs for which they are physically and mentally suited. Because of these immediate returns, the medical department justifies and pays for itself year by year. This very fact of self-maintenance clothes industrial medicine with extraordinary significance as a measure for the general betterment of community health. It is to be recognized that, if full returns are to be derived from this constructive type of health work, means must be found for the institution of the right kind and the right quantity of health conservation into the great number of small plants. The extension of this type of work into small plants, however, is a problem in industrial medicine not as yet solved. In the consideration of these needed services, three approaches have been proposed:

First, the utilization on a full-time basis of a physician not only for medical work but for such other activities as employment management, safety supervision and personnel work. The assumption of all these duties by one person usually warrants the small plant in securing a high type of physician. This proposed approach is manifestly meritorious but is largely impossible through the fact that there are few physicians properly qualified in the several specialties mentioned.

Second, in some localities attempts have been made to solve this matter through the association of several closely situated factories, for the purpose of establishing a dispensary and of employing an industrial physician and such other personnel as may be required to render health supervision to the several factories, participating on a *pro rata* basis. In actual practice, this method has been successfully applied in a few instances. In other instances, it has failed as the result of unequal amount of co-operation from the plants participating.

Third, another approach is to be found in the association of a group of industrial physicians, hygienists, safety engineers, statisticians, etc., for the purpose of rendering to small plants the right type of medical supervision in quantities proportional to their needs. Such an organization daily and regularly spends a certain fixed time in the several plants. For emergencies, services may be had at the plant by communicating with the emergency physician held in reserve for just such purposes. Sanitary and safety investigations are conducted at such intervals as may be deemed desirable from a knowl-

edge of conditions obtaining in the several plants. This method has the advantage of supplying at a low cost to the manufacturer the services of a group of workers qualified in a variety of industrial health and personnel problems.

The subsequent portion of this paper concerns itself with the experience in one small plant of a group of workers whose activities are conducted along the lines last mentioned. An analysis of the results of the industrial medical and hygienic work in this particular factory will, we believe, prove the value of this type of service. The figures shown and the statements made are necessarily somewhat influenced by the shifting of industrial conditions but our conclusions have fully contemplated the effects of such conditions upon our results. The general trend of results points very definitely toward the values of such a part-time medical department both to the health and well-being of the workers, and to the business interests of the management.

## Nature of Business Arrangement

The plant under consideration employed on an average 115 persons, all of whom, with the exception of a small portion of the office force, were men. This plant conducted a combined woodworking and machine shop, the final product being a variety of special machinery. This work was situated in one building having six floors. The general conditions of sanitation prior to the institution of work were unsatisfactory. No sanitary or medical services had been provided, except the usual state factory inspection and the occasional care of emergencies. Following our negotiations with this plant, it was agreed that a single room approximately 10 by 20 feet was to be adequately equipped as a dispensary. The physicians agreed to spend a minimum of one hour daily in the plant at a fixed hour, and to be available for emergencies during any hour of the work-day. Arrangements were likewise devised whereby sanitary and safety investigations would be made at not less than monthly intervals, together with special investigations as deemed necessary by the technical group. An intelligent office worker was designated for training, for the care of trivial injuries and for first-aid purposes until such time as the doctor might arrive. All records concerning compensation awards, etc., were handled by the medical department.

## Approach to the Worker

At the outset of activities, the physician assigned to this plant spent considerable time in the various factory departments under the pretext of studying trades processes. His prime purpose, however, was to become personally acquainted with the majority of the workers and to acquaint them with the function and worth of the newly created department. This procedure also served the purpose of locating several obviously diseased workers. Later these workers were called to the dispensary, and there carefully examined and treated. Good results from these cases, plus some knowledge gained from the doctor on health matters, at once sold the worth of such activities to the entire plant. At about the same time a carefully worded announcement was prepared for all bulletin boards setting forth the prevalence of common ailments among all industrial workers, and the consequences of neglecting them, and instructing the workers that they were privileged to leave their work and consult with the physician for genuine ailments. The re-

sults from these procedures are shown in the next sections in the quantity and nature of the medical work carried out in the ensuing months.

## Experience in Medical and Surgical Relief

Beginning with the first month of our service (May, 1920), 5.2 per cent. of the plant's personnel passed through the dispensary on an average day. This percentage increased until in July of the same year 10 per cent. of the workers daily reported to the doctor for treatment or consultation. Thereafter, the percentage slowly decreased owing to our eradication of many chronic conditions and to the lessening of the number of accidents, until in April, 1921, only 3.1 per cent. of the workers daily passed through the dispensary. Table 1 is a statistical analysis with reference to the number of individuals receiving medical and surgical relief.

## Nature of Physical Conditions Coming to Attention of Physician in This Dispensary

The 1,816 treatments carried out during the year represent 572 precise entities. On an average, all workers passed through the doctor's hands four times

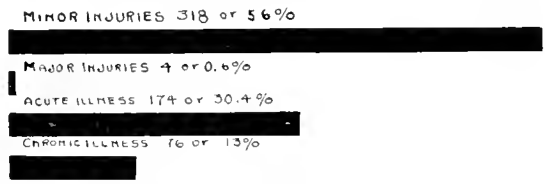


Fig. 1.—Distribution of diseases and injuries.

during the year. The proportion between the various types of cases is shown in Figure 1. For the purposes of our classification, an injury is reported as "major" if a loss of time greater than one week is necessitated. In this work no routine physical examinations were conducted, which fact affects the relative proportion of the items in Figure 1. We believe that chronic diseases, particularly degenerative diseases among old

TABLE 1.—MEDICAL AND SURGICAL RELIEF

| Month | No. of Service Days | Av. No. on Payroll | Total No. on Payroll | Treatments | Av. Treatments per Day | Per Cent. of Personnel | No. of Individuals Served | Av. New Cases per Day | Av. Treatments per Case | Total Hours of Doctor in Plant | Av. Hours per Day | Disability Time Lost | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | Individuals | Days |
| May | 17 | 103 | . . | 109 | 6.4 | 5.2 | 28 | 1.7 | 4.0 | 42.0 | 2.2 | 0 | 0 |
| June | 24 | 112 | . . | 207 | 8.6 | 7.6 | 44 | 1.5 | 4.7 | 72.2 | 2.5 | 5 | 19 |
| July | 26 | 113 | 135 | 257 | 9.9 | 9.7 | 51 | 2.0 | 5.0 | 51.0 | 2.0 | 4 | 15 |
| Aug. | 26 | 126 | 144 | 213 | 8.2 | 6.5 | 47 | 2.4 | 3.4 | 71.0 | 2.7 | 2 | 34 |
| Sept. | 25 | 122 | 145 | 203 | 8.1 | 6.6 | 46 | 2.5 | 3.2 | 50.0 | 2.0 | 0 | 8 |
| Oct. | 26 | 128 | 154 | 193 | 7.4 | 5.8 | 56 | 2.1 | 3.4 | 41.0 | 1.5 | 2 | 7 |
| Nov. | 24 | 138 | 155 | 155 | 6.4 | 4.6 | 42 | 2.3 | 2.7 | 45.5 | 1.8 | 3 | 16 |
| Dec. | 20 | 127 | 140 | 120 | 6.2 | 4.8 | 37 | 2.1 | 2.9 | 25.0 | 1.2 | 4 | 10 |
| Jan. | 25 | 106 | 118 | 84 | 3.3 | 3.1 | 27 | 1.2 | 2.8 | 37.0 | 1.5 | 1 | 13 |
| Feb. | 23 | 106 | 118 | 121 | 5.2 | 5.0 | 36 | 1.7 | 2.8 | 24.5 | 1.0 | 0 | 0 |
| March | 23 | 100 | 113 | 78 | 3.4 | 3.4 | 23 | 0.9 | 3.4 | 22.0 | 1.0 | 0 | 0 |
| April | 24 | 98 | 100 | 76 | 3.1 | 3.1 | 19 | 1.0 | 4.0 | 5.0 | 0.8 | 0 | 0 |
| *Total* | 283 | . . | 1,322[1] | 1,816 | . . | . . | 456 | . . | | 486.2 | . . | 21 | 122 |
| *Av. per Month* | 23.5 | 113 | 132 | 151.3 | 6.3 | 5.45 | 38 | 1.78 | 3.5 | 40.5 | 1.6 (1 hr. 35 min.) | 1.75 | 10.1 |

[1] Totals for May and June not kept.

men, greatly exceed the relatively small number coming under our observation. Although proof is lacking, there are reasons to believe that less than 10 per cent. of even the most trivial injuries failed to come under the observation of the medical department. In short, it is maintained that the work of the dispensary has met the problems of medical and surgical relief as well as they are customarily met by a full-time personnel in a large plant.

## Accomplishments in Sanitation and Hygiene

At the outset of work, it was recorded that the conditions of general sanitation in this plant were bad. The plant was of the well-known type having no drinking water facilities except coolers with common drinking cups and over-chilled water; very bad lighting, both artificial and natural; no provisions for hot water for washing purposes and no facilities for any washing, except rusty iron sinks with cold running water. The plant was characterized by the marked disorderly arrangement of materials and of some equipment. Dirt and dust and "junk" had accumulated throughout the plant.

The new managers of this plant were themselves aware of bad conditions and gave full co-operation in the betterment of most of the defects in working conditions brought to their attention by the physician. At the end of one year, on checking up measures and mechanism for the betterment of working conditions, the following improvements were found to have been instituted or installed:

(*a*) A drinking water system with one outlet for each group of about thirty men was installed.

(*b*) Washing facilities were much improved through the installation of a hot-water system and an increased amount of available washing equipment.

(*c*) Improved natural lighting was secured through the establishment of the custom of routine window washing. Distinct betterment of artificial lighting was obtained through the installation of standard lighting equipment practically throughout the plant.

(*d*) Improvement in the order of the plant was effected through proper storage of much antiquated material and machinery, through the proper piling of materials, and through the use of metal containers for small parts.

(*e*) The general cleanliness of the plant was improved through the services of a hard-working porter.

(*f*) The ventilation of various factory departments was partially remedied through the regulation of open windows, for air motion, etc.

(*g*) A great many minor improvements were instituted in every department. It is undesirable that these be individually listed but some idea of their nature may be gained from the citation of such examples as the correction of bad posture conditions in isolated cases, extension of the exhaust system, increased heating facilities, etc.

## Accomplishments in Safety Work

The part-time medical department was charged with full responsibility for all safety activities in the plant. On making a general tour of inspection and inquiries at the inception of our health work, it was evident that this plant was protected only to the minimum by mechanical guards, that such as were present were largely due to the requirements of state factory inspection, that many guards which had been installed were not in use, and that the spirit of safety was not present either among workers

and foremen, or among all of the executives. On all sides many specific hazards were readily discernible.

During one year of service many distinct accomplishments in safety betterment were secured.

(*a*) A safety committee was formed which, however, was only participated in by foremen, sub-foremen and executives on account of a fixed administrative policy.

(*b*) A bulletin board service was established in all departments, using both standard posters from commercial services and posters prepared by the medical department based on actual plant conditions or particular accidents.

(*c*) All machinery was carefully studied. Numerous guards were built and installed, and various faulty practices were corrected.

(*d*) In special instances, a study was made of the mental and physical adaptability of workers to their particular jobs. This necessitated the shifting of various workers in the interest of the plant and safety.

(*e*) An automatic fire-alarm system was installed.

(*f*) During this period the practice of monthly fire drills was instituted.

(*g*) Numerous general improvements were made in safety conditions through such innovations as improved lighting, improved orderliness, automatic shut-off of power for emergencies, etc.

In general, it is maintained that the accomplishments in safety through this part-time service were adequate.

## Costs of This Part-Time Medical Service

The expenses incident to the equipping and fitting up of the dispensary were approximately $600. These costs have been so amortized that $100 is the amount properly chargeable to this one year's experience. The recurring expense for drugs, bandages, etc., averaged $5 per month for a year. For services in medicine, hygiene, sanitation, etc., a charge of $200 a month was made. By agreement all state compensation checks, which ordinarily would have been paid out to a neighborhood physician, were returned to the plant physician and in turn were given over to the company. This practice appreciably lowered the cost of services to this plant. The returns of such state checks for the several months are indicated below:

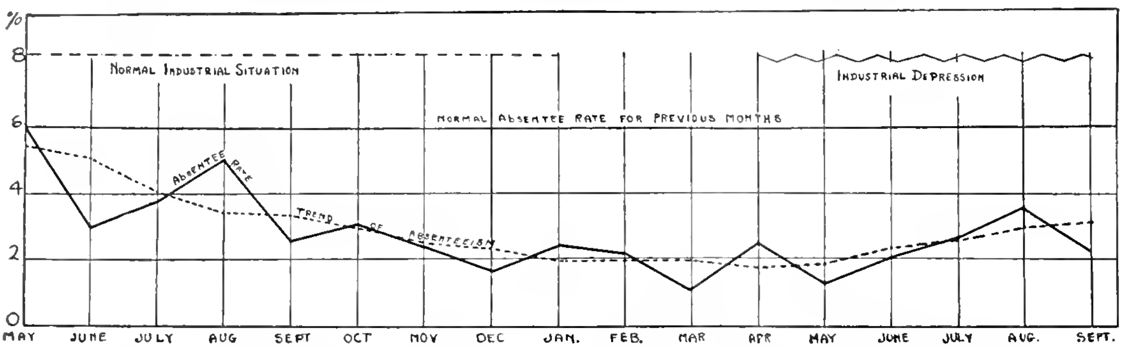


Fig. 2.—Absentee rate and trend of absenteeism during period from May, 1920, when industrial medical service was started, to April, 1921, when medical service was discontinued, and from April, 1921, to September, 1921, when physician was on call only.

| | |
|---|---|
| June | $ 97.25 |
| July | 137.75 |
| August | 91.25 |
| September | 125.95 |

| | |
|---|---|
| October | $104.75 |
| November | 41.80 |
| December | 79.75 |
| January | 63.50 |
| February | 39.00 |
| March | 6.50 |
| April | 105.50 |

The actual cost for services was thus $1,667.00, which gives an average of $139.00 per month or, on a basis of an average of 115 workers, $1.20 per employee per month, or $14.40 per year. These supplied figures do not take into consideration the costs of the various sanitary and safety appliances installed nor do they include any charge against the medical department for loss of time of employees while off their jobs in the dispensary under treatment.

## Benefits to the Plant Owners

In the foregoing sections of this paper we have set forth the quantity, the nature, and the costs of our activities in this small plant. Persons to whom the reading of this paper will be a matter of interest will accept without argument the benefit of this type of work to the sick or injured individual worker and to the workers as a group. There remains, however, the necessity of recording the advantages accruing to the plant management, in return for the money paid out for these activities.

In this plant prior to the inception of our work few compilable records were kept of absenteeism, turnover, accident frequency and of such other matters as later would enable a determination by comparison of the worth of human conservation. Moreover, before and after the commencement of our work no precise methods obtained in the plant for measuring the work output of individuals or the morale of the plant's workers. In the absence of precise evidence in these last named respects, no claims will be made to accrued advantages based on opinions. Proof, however, is available in other aspects of work, some of which follow.

(*a*) *Absenteeism.*—Records of absenteeism were instituted at the time of beginning the medical department work. The experience of this first month yielded a daily absentee rate of 6 per cent. From inquiry into available records we came to accept this rate as about normal for previous months. This rate refers to absenteeism from all causes, except vacations. Immediately, as the result of our activities, the absentee rate fell to 3 per cent. (Fig. 2). Accurate records for the ensuing eleven months are as follows:

| | Per Cent. |
|---|---|
| June | 3.0 |
| July | 3.8 |
| August | 5.0 |
| September | 2.6 |
| October | 3.1 |
| November | 2.4 |
| December | 1.7 |
| January | 2.5 |
| February | 2.2 |
| March | 1.1 |
| April | 2.5 |

The average absentee rate for the year, excluding the first month, was 2.7 per cent. This is a saving of 3.3 per cent. of the work force through protective measures. It thus appears that on a yearly basis, 3.8 men were daily kept at work, who otherwise would have been absent. This aggregates a saving of 1,140 days in the course of a year. In this plant, because of the nature of its work, it is accepted that the readjustments required in the event of the absence of an employee occasion a plant loss equivalent to the worker's pay. At the low figure of $3 per day as the average wage, $3,420 accrued as savings from this item alone.

(*b*) *Turnover Rate.*—Evidence arising from turnover rates as a criterion has, during recent months, been subject to marked fallacies owing to industrial conditions. In this city, industrial depression in general, and particularly in this industry, was not felt until about January, 1921. For this reason, our computations only embrace our service months during 1920. In seeking to establish a labor turnover rate prior to the commencement of health supervision, we were led to the acceptance of 25 per cent. monthly as normal. This unusually high figure was in part brought about through the employment in this factory of a considerable number of old men and of young boys, among whom the turnover rate was known to be high. This accepted turnover rate is borne out by the first two months' experience which again averaged 25 per cent. Following these two months the rate appreciably decreased as follows:

| | Per Cent. |
|---|---|
| July | 15.0 |
| August | 10.3 |
| September (high rate due to return of young boys to school) | 22.0 |
| October | 16.0 |
| November | 13.0 |
| December | 12.0 |

The average turnover rate for the six months under consideration was 14.7 per cent. The costs of labor turnover are well known to both manufacturers and industrial physicians. The abovementioned reduction of the rate yielded visible money returns for the money invested by the management in the medical department.

(*c*) During the entire period of service in this potentially hazardous plant, not one accident occurred resulting in an award for permanent disability. Although many trivial accidents occurred, none was of such severity that even a single phalanx was lost.

(*d*) During this period of one year, only twenty-one persons were absent from work on our advice because of injury or sickness. Although 322 injuries of all degrees are recorded, only four were of such severity as to cause a loss of more than one week's time.

(*e*) For every thousand man days of factory work, only 0.6 individuals lost time on account of injury or sickness.

(*f*) The average loss of time in hours for persons absent on account of injury or sickness was fifty-two hours.

The significance of such results as these in a hazardous plant will be appreciated by industrial executives and physicians without an attempt on our part to compute in dollars and cents the worth of such measures. In addition to the returns cited, many other benefits from medical work of the kind mentioned will be accepted by all.

## Summary

The number of workers employed in small factories exceeds the number engaged in work in plants of 500 or more employees. Proportionally, work conditions are less satisfactory in small factories than in larger plants. It is desirable that some means be found to apply to the small plant the same type of health conservation measures that have proved so successful and so valuable in larger plants. The experience of a group of industrial health workers in a small plant averaging 115 employees is recorded. The results of such work have been of sufficient benefit to justify the assertion that this procedure may successfully be applied to small plants in general.

# METATARSOPHALANGEAL FRACTURES, WITH A REPORT OF TWENTY-SEVEN CASES*

Alfred G. Bolduc, M.D.

*Bayonne, N. J.*

A LARGE proportion of contusions and bruises of the feet are treated as such and consequently do not do well. This is especially true of injuries of the toes. These cases are characterized by continuous throbbing pain, tenderness to pressure, persistent ecchymosis, swelling, and in some cases localized edema, the underlying cause of which symptoms, as revealed by the X-ray, is often a fractured bone. Indeed, I have come to the conclusion, after several years' study of foot injuries, that the X-Ray is the only sure method of revealing the existence or non-existence of metatarsophalangeal fractures, and their exact location. As a routine procedure, therefore, I have a skiagram taken of all foot injuries which warrant the least suspicion that a fracture might exist. (See Figs. 1 and 2.)

All of the cases of metatarsophalangeal fractures here reported were due to direct violence, and with one exception—namely, Case 12, in which the fracture was caused by a heavy hand truck passing over the patient's toes—they had a history of some heavy object falling on the foot. (See Table 1.) Nearly all of the cases were seen immediately after injury, and all within one hour after injury, at which time practically the only symptoms exhibited were sharp, intense exquisite pain at the location of the fracture, and ecchymosis.

The symptoms in foot fractures, of course, vary. Inability to bear weight on the foot and localized tenderness were the only symptoms in Case 21. Ecchymosis is quite constant but not always present. Crepitus is absent in the majority of metatarsophalangeal fractures, as is also mobility. Deformity is rare, unless swelling is so classified.

Fig. 1. Case 10, showing comminuted fracture of distal phalanx of left great toe and also of first toe.

The types of fracture represented by the twenty-seven cases reported in this article are, in the order of their frequency, chip fractures, fractures of the proximal phalanx, and fractures of the metatarsal bones.

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### Chip Fractures

Comminuted fracture, simple or compound, of the distal phalanx, known to the industrial surgeon as chip fracture, is the most common type of fracture of the foot, yet it receives scant attention in our textbooks and in other medical literature as well. These fractures present a very characteristic picture, even when seen immediately after injury. The most prominent symptoms are severe pain, discoloration caused by the extravasation of blood into the tissues, and swelling. In some cases pain on palpation is the only symptom.

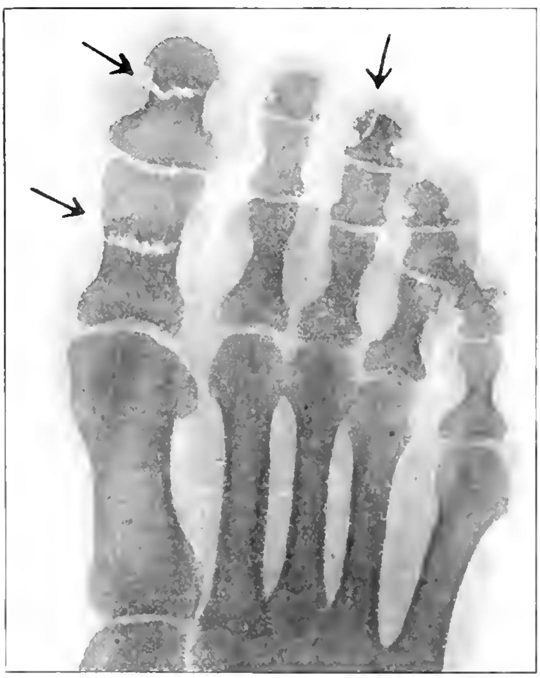

Fig. 2.—Case 26, showing fracture of distal phalanx and proximal phalanx of right great toe, and chip fracture of distal phalanx of right second toe.

It is my experience that compound chip fractures heal more quickly and are less painful than the simple fractures when given expectant treatment. On study of the anatomy of the toe, dense connective tissue is found over the adipose tissue and underlying structures, and this tends to form a capsulated sac which holds the extravasated blood caused by the fragments of bone injuring the surrounding tissue. This pressure in the sac causes great pain. Sometimes the blood escapes to the nail bed, and is then very easily detected. In such cases expectant treatment does no good, and it is my practice to incise the toe, using a cataract knife or a sharp-pointed scalpel. The site of incision varies, but the lateral aspect gives the most uniform results. An incision deep enough to free the extravasated blood is required. When free drainage of the blood is established, the throbbing pain ceases, the toe uniformly gets well, and the period of disability is remarkably lessened. The danger of latent infection is practically eliminated. In fact, I have never had a case of infection when prompt surgical intervention was employed. In some cases it is advisable to puncture or raise the nail, especially if there is blood beneath it. This can be done with sharp-pointed scissors. Expectant treatment is then given.

The surgical treatment of chip fractures must be carried out under strictly aseptic conditions. Personally, I swab the part with a 5 per cent. solution of picric acid in 95 per cent. alcohol. Tincture of iodine can also be used. Cocaine or apothesine is used as a local anesthetic, and the operation is rendered painless. Wet antiseptic dressings are used for two or three days after the operation in order to prevent any possible infection with skin organisms.

As a result of my experience, I have become convinced that the X-ray offers the only sure method in the diagnosis of chip fracture, and that surgical interference in simple chip fractures is the proper procedure.

TABLE 1. — REPORT OF CASES OF METATARSOPHALANGEAL FRACTURE

| Case No. | Reg. No. | Date of Accident | Cause of Accident | Time Disabled | X-ray Diagnosis | End-Result |
|---|---|---|---|---|---|---|
| | | | | *days* | | |
| 1 | 50 | 3–18–20 | iron bar fell on foot | 17 | comminuted (chip) fracture of distal phalanx of left great toe | no disability |
| 2 | 355 | 10–29–20 | steel plate fell on toe | none | longitudinal fracture complete of distal phalanx of right great toe | " " |
| 3 | 510 | 1–18–20 | casting fell on foot | 8 | longitudinal fracture of distal phalanx of left great toe | " " |
| 4 | 583 | 12–3–19 | steel plate fell on foot | none | comminuted fracture of distal phalanx of left great toe | " " |
| 5 | 809 | 1–17–20 | steel bar fell on foot | none | comminuted fracture of distal phalanx of right great toe | " " |
| 6 | 866 | 2–3–20 | steel plate fell on foot | 8 | comminuted fracture of distal phalanx of right great toe | " " |
| 7 | 980 | 11–29–19 | iron bar slipped and fell on foot | 26 | comminuted fracture of proximal phalanx of left great toe | " " |
| 8 | 989 | 11–15–19 | steel plate fell on foot | 29 | comminuted fracture of distal phalanx of left great toe | " " |
| 9 | 1232 | 8–10–20 | heavy piece of iron fell on foot | 4 | comminuted fracture of proximal phalanx of left great toe | 15% disability of great toe |
| 10 | 1384 | 8–15–20 | box fell on toes | 12 | comminuted fracture of distal phalanx of left great toe and also of first toe | no disability |
| 11 | 1771 | 1–21–21 | heavy piece of pipe fell on foot | 21 | comminuted fracture of distal phalanx of right great toe and of first toe | " " |
| 12 | 2314 | 11–15–19 | foot caught under wheel of truck | 17 | comminuted fracture of distal phalanx of right great toe | " " |
| 13 | 1107 | 12–1–19 | heavy iron bar fell on foot | 38 | transverse fracture of phalanx of first right toe | " " |
| 14 | 1166 | 3–23–21 | iron plate fell on toes | 10 | comminuted fracture of distal phalanx of third right toe | " " |
| 15 | 1365 | 3–8–21 | heavy box fell on toe | 8 | incomplete fracture of distal phalanx of right little toe | " " |
| 16 | 2187 | 2–10–21 | piece of iron fell from crane onto foot | 7 | comminuted fracture of distal phalanx of left first toe | " " |
| 17 | 2645 | 2–15–20 | plank fell on foot | 23 | transverse fracture of proximal phalanx of left great toe | " " |
| 18 | 2710 | 1–4–21 | heavy plank fell on foot | 7 | incomplete fracture of proximal phalanx of left great toe | " " |
| 19 | 2721 | 10–21–21 | heavy iron bar fell on foot | 7 | comminuted fracture of distal phalanx of right first toe | " " |
| 20 | 9 | 4–7–21 | casting fell on foot | 30 | complete fracture of first metatarsal bone | " " |
| 21 | 514 | 7–18–21 | heavy piece of iron fell on foot | 37 | complete fracture of second and third metatarsal bones | " " |
| 22 | 1218 | 11–16–20 | heavy forging fell on foot | 8 | longitudinal fracture of first metatarsal bone | " " |
| 23 | 915 | 7–15–20 | heavy piece of iron fell on foot | 40 | fracture of proximal ends of third and fourth metatarsal bones | " " |
| 24 | 1166 | 5–15–19 | heavy bar of steel fell on foot | 21 | fracture of first, second, and third left metatarsal bones | " " |
| 25 | 1166 | 3–4–20 | heavy box fell on foot | 24 | fracture of first left metatarsal bone | " " |
| 26 | 1159 | 9–7–21 | heavy iron door fell on foot | 30 | fracture of distal phalanx and proximal phalanx of right great toe, and chip fracture of distal phalanx of right second toe | " " |
| 27 | 1202 | 2–10–22 | 1 ton iron frame fell on foot from height of 6 inches | 42 | fracture of first, second, third and fourth right metatarsal bones | " " |

### Fractures of Proximal Phalanx

Seven of my cases were fractures of the proximal phalanx, all caused by direct violence. Inability to stand on the injured member without intense pain was the only symptom in Cases 17 and 18. The other cases presented the usual fracture symptoms, excepting mobility and crepitus—symptoms which were exhibited in Case 13 only. Permanent disability occurred in but one instance, namely, Case 9. This patient was unmanageable and did not follow treatment. His disability was a loss of about 15 per cent. of the function of the great toe, caused by a partial ankylosis of the interphalangeal joint.

Conservative treatment was given in all these cases, as they were simply fractures without much displacement. A plaster cast covering the whole foot from toes to the ankle was applied. This immobilized the foot, and the weight of the cast prevented the patient from using the injured member. Rest and disuse of the foot is paramount to good end-results. The disability period averaged twenty days, the longest period being thirty-eight days.

### Fractures of Metatarsal Bones

Six of my cases were simple metatarsal fractures, all caused by direct violence, *viz.*, some heavy object falling on the foot. Clinically it was impossible to make a diagnosis in three of these cases. Inability to bear weight on the foot, and exquisite, localized pain were the outstanding symptoms in all cases. Swelling and ecchymosis accompanied all cases excepting Case 21. Cases 24 and 25 were the only ones in which crepitus and mobility were detected, and in which deformity was in evidence.

A correct history of any foot injury, with moderate or severe clinical symptoms, is essential for a correct diagnosis. The X-ray sometimes shows a fractured metatarsal bone where it is least expected, thus eliminating doubtful cases, and it should, therefore, be used as a routine in contusions caused by severe direct blows.

The treatment in all these cases of metatarsal fracture, excepting Case 27, was the same. After good apposition was established, a plaster-of-Paris cast was immediately applied, with a steel wire saw underneath. When the cast

Fig. 3.—Case 27, showing fracture of first, second, third and fourth right metatarsal bones.

had hardened, it was cut with the saw, and then bandaged, in order that, if the foot swelled to any extent, the cast could expand accordingly, and no unnecessary pressure pain result. The period of wearing the cast was about three weeks,

but disability as a rule extended a week or two longer. In Case 27 the fracture of the first metatarsal bone could not be reduced by ordinary methods and kept in place. (See Fig. 3.) I therefore operated on the patient's foot, drilling and suturing with Kangaroo tendon, and in this way procured perfect apposition. At the present time all my patients are working, and not one complains of any ill results from his injury.

## Summary


1. The outstanding symptom in all metatarsophalangeal fractures is exquisite, localized pain.

2. In severe contusions of the distal phalanges always have a skiagram taken, as experience has shown that fractures are very common and that they are not trivial things.

3. Conservative treatment in simple comminuted fracture of the distal phalanx is contraindicated. Surgical interference hastens the cure and prevents latent infection.

4. All cases of severe contusions and bruises of the feet should be treated as fracture cases until proven otherwise.

5. Apposition of fragments in phalangeal and metatarsal fractures should be as nearly normal as possible. Surgical procedure should be resorted to if other methods fail in the desired results.

6. End-results in metatarsophalangeal fractures are uniformally good if proper treatment is given.

7. In the diagnosis of metatarsophalangeal fractures the X-ray is indispensable.

# THE ESTABLISHMENT OF A DENTAL CLINIC*

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*The J. G. Brill Company, Philadelphia*

WAR experience has added conviction to our conception of the utility of preventive dentistry. It has become unnecessary to argue for the value of dentistry in relation to industrial health, and the only phases of the subject which today merit discussion are the manner of establishment and the organization of the industrial dental unit.

In February, 1920, the author submitted for the consideration of the management of The J. G. Brill Company an outline of the various types of industrial dental dispensaries, and at the same time made the suggestions that the second type of organization described be adopted, and that the dental clinic come directly under the supervision of the medical director who would be responsible for its success or failure. The following are the four kinds of industrial dental dispensaries submitted for consideration:

1. Those wherein only examinations and prophylaxis are done.

2. Those wherein examinations, prophylaxis, and fillings are done and a nominal charge made to the employee.

3. Those wherein all types of dentistry are done for employees entirely at the company's expense.

4. Those wherein work is done for the employees' children. This is building for future employees.

Choice of any one of these groups will depend upon local conditions and upon the type of industry to be served. In the case of The J. G. Brill Company the second group was chosen, and the work done includes examinations, treatments, extractions, procaine extractions, cleaning, and cement and porcelain fillings. All work is done in company's time, and all employees are classed alike, except that those who have been employed less than six months must pay regular dental rates, the difference being refunded after six months' employment.

After careful consideration the following nominal charges were evolved:

| | | |
|---|---|---|
| Examination free | | |
| Treatment | .25 | cents |
| Extractions | .25 | " |
| Gas extractions | .50 | " |
| Procaine extractions | .50 | " |
| Cleaning | .50 | " |
| Amalgam fillings | .50 | " |
| Porcelain fillings | .75 | " |

The dentist is paid a salary by the company and is permitted to make appointments for gold work, plate, crown and bridge work in his own office outside of company time and, of course, at regular dental rates. We believe that such an arrangement will always be successful if the dentist is the right type of man. The employees treated in the clinic make all their payments through the paymaster's office. Directly in front of the dentist's chair we have placed a sign reading "Money due for dental work will be deducted from your next pay envelope." We have also displayed the charges conspicuously and have thereby avoided controversies most satisfactorily.

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The dentist's hours will of course vary with the size of the industry. In this company, with an employment roll of 1,511, we started with three mornings a week from 8 to 12 A. M., but since the business depression have reduced the time to two mornings a week. This, naturally, will be increased as business returns to normal. Since the treatments are on company's time we have found it necessary to demand that all appointments be made between 8 and 8.30 A. M. This has facilitated the work very materially, has lessened confusion, and has prevented unnecessary trips to the dental office. Emergency work is, of course, an exception, and is cared for without preliminary arrangements.

A dental clinic can be installed in an exceedingly expensive manner, yet good results can be secured with an organization established on a more economical basis. Our equipment has consisted of one dental chair, one foot engine and right angle hand piece, one instrument cabinet, assorted instruments and material. This equipment has served our industry with a maximum of efficiency and a minimum of cost.

The work of the dental clinic, summarized from our records for the period of twenty months from March, 1920, to November, 1921, is as follows:

| | |
|---|---|
| Number of patients | 1,735 |
| Number of emergency treatments | 1,621 |
| Number of cleanings | 353 |
| Number of teeth extracted | 507 |
| Number of fillings | 899 |
| Number of treatments | 474 |

The gross operating cost for this period, including the dentist's salary, insurance, depreciation, interest, and cost of material, was $1,381.89. The receipts for the same period were $1,134.75. The actual cost to the company was thus $247.14, or a little over $12.35 a month.

The dental clinic as we have established it has, therefore, been very inexpensive, and its value as a part of our health service has been beyond cavil or question. The extent to which our employees have taken advantage of it removes all doubt upon this point, for unless the service rendered met the need in a substantial manner the patronage of the clinic would have fallen away, and this it has not done.

# REPORT ON AN INVESTIGATION TO DETERMINE THE HAZARD TO THE HEALTH OF OPERATORS USING THE SPRAYING MACHINE FOR PAINTING: THE RISK OF LEAD POISONING*

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At the request of the division of Industrial Hygiene for Ontario and the Committee on Industrial Fatigue, the Department of Pharmacology of the University of Toronto undertook an investigation of the hazard to the health of operators of paint-spraying machines.

The manufacturers of paint-spraying machines obviously realize that there may be a risk involved in their use as they describe in their advertisements and show in their exhibits paint-spraying machines with systems for the control of the spray by means of cabinets, fans, helmets or masks. The prohibition of the use of spray machines by legislation in various states has been considered, but up to the present time has been defeated in committee or withheld for further consideration.

The dangers involved in the use of paint depend on the constituents of the paint and the method of applying it. Paint consists of pigment, linseed oil, turpentine, thinners and driers. Either pigment or vehicle may be poisonous. The pigments used are mainly lead, zinc, barium, iron and lithopone (barium sulphate and zinc sulphide). We have no reason to believe that pigments other than lead in the forms used give symptoms of poisoning. Dr. Hamilton in *Hygiene of the Painters' Trade* (1) says that the dangerous pigments are the different salts of lead. The British Departmental Committee on the Danger in the Use of Lead in the Painting of Buildings (2) recommends a law prohibiting the use of paint material which contains more than 5 per cent. of its dry weight of a soluble lead compound. The Committee does not consider other pigments dangerous, but suggests the possibility of danger from the liquid vehicles.

According to Legge and Goadby (3, p. 291) the causes of lead poisoning in painting are arranged in the following order of importance: (*a*) dust from sandpapering one surface of lead paint before applying another; (*b*) dust from mixing dry white lead with oil; (*c*) dust arising from lead paint that has dried on overalls and dripcloths; (*d*) contamination of food by unwashed hands; (*e*) fumes from burning off old paint. The British Departmental Committee above mentioned emphasizes the fact that the center of danger in all lead industries is in the dust produced. There is a diminution in the death rate and in the number of cases of poisoning following the reduction of lead dust in dangerous lead processes (4). The poisonous nature of any lead compound varies with the size of the particles, the ease of their distribution in the air, and their solubility in the normal body fluids.

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Oliver (5) raises the question as to whether the symptoms of so-called lead poisoning of painters are always and really due to lead. Goadby (4) is of the opinion that the illness complained of by house painters is more often the result of turpentine and thinners used than of lead.

Lead may gain entrance to the body in two ways: (*a*) by the respiratory system as a consequence of inhaling lead-dust-laden air; and (*b*) by the alimentary system. Legge states that there is every reason to believe that lead absorbed through the lung produces the maximum toxic effect. Lehmann, Saito, and Gfrorer (6) at first found that as high as 35 to 42 per cent. of inhaled white lead dust reached the lungs, and in mouth-breathers as high as 80 per cent. As a result of further experiments, however, Lehmann, Saito, and Majima (7) later state that usually 12 per cent. reaches the lungs and 70 per cent. the alimentary system. Of the inhaled lead dust, the part caught in the mouth and throat would be mixed with saliva and swallowed. Food contaminated by lead, and lead carried on pipes and cigarettes used in working hours add to the quantity swallowed. The risk from these latter modes of entrance may be small but it might well be sufficient to cause the breakdown of a constitution already undermined by lead poisoning.

The conclusion drawn by the British Departmental Committee is that lead-laden dust is by far the most serious evil, and the first of the necessary precautions which it recommends is "efficient measures for the avoidance or removal of dust or spray which is formed in the course of work and contains lead in its composition." Goadby has emphasized the danger of long-continued inhalation of even very small quantities of lead-laden dust, showing that an animal exposed to such an atmosphere during eight hours each day for sixteen months, while showing no symptoms of poisoning, has nevertheless undergone such constitutional deterioration as to succumb to a dose of lead insufficient in amount to produce symptoms in a normal animal.

In Toronto, there are thirty or more firms using from one to three spraying machines each. These machines are used for the inside and outside of factories and in painting, varnishing and shellacking small articles. Several painters own spray machines, and use them on occasional contracts. During this investigation, no painting of exterior walls was observed. When painting walls and ceilings inside buildings, exhaust ventilators for the removal of spray and fumes cannot be used. Masks were worn by two operators under observation, and in one instance the machine was equipped with an extension to keep the spray nozzle at least 10 feet from the operator.

For painting small articles practically all machines have an exhaust system of hoods and fans. Only an occasional operator on such machines uses a mask. Some wear gloves; others use vaseline on the hands and arms. Most of the operators whom we observed, however, depended on the exhaust system for protection from the spray. In all cases but one, the operators said that, as far as they knew, it was rarely that a paint containing lead was used. In the one exception, a paint was used in which 0.3 per cent. of the pigment was lead. In some cases, any lead paint used was applied by a brush.

As no lead paint was used, save small amounts in the case above mentioned, and as the operators had other duties, such as the dilution of the paint for spray purposes, the filling of containers,

the handling of the painted articles, or painting by brush, the operators were unsuitable for estimation of the hazard due to the lead in spray painting alone. Consequently, an experimental test of the danger of lead poisoning in spray painting was made.

A paint was mixed in accordance with a typical formula for interior work as suggested by Dr. Hamilton (1), in which the pigment consisted entirely of white lead and was 60 per cent. of the whole, the liquid portion being mainly of linseed oil and turpentine in nearly equal parts. This mixture was diluted with benzine to the necessary consistency for spray painting. Air pressure from an automatic pump was kept between 35 and 55 pounds per square inch, and the spray was directed against a vertical surface of wall. Specimens of air were collected by being drawn through suction cylinders containing water or dilute acid, the air being broken up by a finely perforated bulb on the suction tube. Other air specimens were collected by Duckering's method (8), in which the air is drawn through a glass tube which enters at a right angle into a collecting bottle of larger caliber, in order to reduce the velocity of the air current. The collecting bottle expands at the bottom into a larger chamber, of which the upper surface makes a right angle with the collecting bottle. This chamber is packed with cotton-wool and the end covered with silk. Air is sucked through the collecting bottles by means of a calibrated pump at the ordinary rate of breathing. Samples of air were taken at the various positions likely to be occupied by the nose and mouth of a spray painter, 300 liters of air being used for each estimation. To study the distribution of the spray, porcelain plates varying in surface area from 12 to 50 sq. cm. were laid horizontally in different positions for half-hour periods.

In estimating the lead, it was treated as if in organic combination, for it was probable that all lead particles would be surrounded by a layer of oil. The material collected on the plates was therefore treated with sulphuric acid and ashed at low temperature in a muffle furnace. The ash was then boiled with ammonium acetate made alkaline with ammonia water. This solution was filtered into a Nessler tube, two drops of potassium cyanide solution added and then 10 c.c. of fresh hydrogen sulphide water. The turbidity developed by the hydrogen sulphide water was matched with standard tubes of lead solution, similarly treated with ammonium acetate, ammonia, potassium cyanide and hydrogen sulphide water. All glassware and solutions were tested for lead before proceeding with the colorimetric tests. In the case of the air samples collected on cotton-wool, the estimations were made by the method devised by Harcourt (9), in the course of which it was necessary to add to the standards a colored solution of cotton-wool dissolved in nitric acid, evaporated to dryness, and the residue dissolved in water.

These experiments were done in a large room with a low ceiling, so there was a tendency for the fumes to roll back toward the operator. Moreover, there was no direct draft to carry away the fumes. A mist could easily be seen 10 feet and more to the side; the operator and his assistant had slight choking sensations which persisted for some time after the exposure; the boots and clothing showed a fine coating of paint; the external nares were "frosted." In the case of a painter observed when engaged in painting the walls of a factory basement, the outlines of the mask which he wore over his nose and mouth were well marked by the fine coating of paint

on the rest of his face. His arms were also coated. There were no drip spots on the floor, however.

The collecting apparatus was taken to a factory where small objects (some with a surface area of from 1 to 2 square feet) were spray painted in a cabinet provided with excellent suction. This cabinet was on a stand about 4 feet from the floor and had an open front about 3 feet square, through which the objects to be sprayed were passed into the cabinet. The operator, therefore, could remain entirely outside the cabinet while working or could lean forward into the cabinet if he wished to do so. Air specimens were collected at the positions occupied by the operator's mouth and nose when working; plates were exposed in different places in the cabinet at the furthest level forward which the body of the operator could assume. Plates were exposed outside the cabinet also. There was no unpleasant sensation when breathing at the operator's position, though there was an odor of paint. No film was found on the clothing, nor was the operator's face coated. The hands and arms of some operators were coated owing to placing the arm in the cabinet to move the object sprayed or to turn the table on which it revolved.

From Duckering's analyses of lead present in the air during certain pottery processes and during sandpapering after painting (8), Legge has concluded that, if the amount of lead present in the air breathed is less than 5 mg. per 10 cubic meters of air, cases of encephalopathy and paralysis will never occur, and cases of colic rarely. A workman inhaling 600 c.c. of air sixteen times per minute in an eight-hour working day breathes in 4,608 liters of air. If the inspired air contains 5 mg. per 10 cubic meters, this means that in one day he will breathe in about 2 mg. of lead—the amount regarded by Legge as the lowest daily dose which, inhaled as fumes or dust in the air, may in the course of years set up chronic plumbism (3, pp. 176-207). He considers that 2 mg. of lead per day may be excreted in the feces of a lead worker without being regarded as showing that he is in danger of poisoning by lead. Legge was aided in his conclusions by an intimate knowledge of the processes examined by Duckering, the relative frequency of cases of plumbism reported among those employed at these processes, and the duration of employment prior to attack. In the case of sandpapering coach wheels, the enormous quantity of 1,025 mg. per 10 cubic meters was found in the air, and this process of dry rubbing is placed highest among the causes of lead poisoning. Kaup of Vienna (2, p. 79) found from 10 to 250 mg. of lead per 10 cubic meters of air in a room in which dry rubbing down was done. It is the opinion of Teleky (10) that a daily dose of a little more than 1 mg. of lead taken for several months will cause plumbism, and that a daily dose of 10 mg. will cause symptoms of severe saturnine intoxication in a very short time. In our experiments, as may be seen from Table 1, 135 to 417 mg. of lead per 10 cubic meters of air were found when spraying an inside wall; this is obviously a dangerous amount. In an eight-hour day at such work, a workman would breathe in from 60 to 180 mg. of lead.

Legge has also placed the minimum quantity of lead required to produce poisoning at about 5 mg. per kilogram body weight. This amounts to 350 mg. for a man of 150 pounds' weight. Our figures show that a workman employed in spraying an inside wall might in a few days absorb 350 mg. of lead over and above the amount which he can excrete.

Consequently, he is exposed to a highly dangerous degree.

The plates exposed for half-hour periods during the spraying of an inside wall show that lead was deposited 11 feet to the right of the operator and 3 feet behind him. (See Table 2.) The mist during spraying could easily be seen at these distances.

TABLE 1.—ANALYSIS OF AIR SAMPLES IN SPRAYING AN INSIDE WALL

| Position of Mouth of Collecting Tube | Mg. of Lead per 300 L. of Air | Mg. of Lead per 10 Cu. M. of Air |
|---|---|---|
| 2 ft. from wall sprayed, at level of operator's mouth; sample collected by filtering through cotton-wool | 6.25–12.5 | 208–417 |
| 2 ft. from wall sprayed, at level of operator's mouth; 3 ft. to right of operator; cotton-wool filter | 4.06 | 135 |
| 1 ft. from wall sprayed, at level of mouth; 4 ft. to right of operator; cotton-wool filter | 6.25 | 208 |
| 1 ft. from area sprayed; 1 ft. below level of mouth; 1½ ft. to left or right; samples filtered through water or dilute acid[1] | 2.04–3.12 | 68–104 |

[1] Water or acid collectors were not as efficient as cotton-wool filters.

During a three-day experiment in spraying an inside wall, the operator was exposed to the spray for from four to five hours daily. The urine of the twenty-four hours following showed the presence of 0.3 mg. of lead. The feces also showed the presence of lead but less than the 2 mg. considered by Legge as indicating danger of poisoning. The presence of lead in the urine from a short exposure is significant. The operator did no dry mixing but used white lead already mixed with oil. Though he diluted paint and handled apparatus during the painting, he took care to prevent his food and tobacco from being contaminated. It is probable, then, that all the lead in the urine came from the spray. As it was not expected that the urine and feces would show the presence of lead, no specimens were saved other than those of the first twenty-four hours after painting. Later specimens of feces would probably have shown increased amounts of lead.

TABLE 2.—ANALYSIS OF DEPOSITS ON PORCELAIN PLATES IN SPRAYING AN INSIDE WALL[1]

| Position with Reference to Operator | Distance in Feet from Wall Sprayed | Mg. of Lead per Sq. Cm. of Plate Exposed for Half-Hour Interval |
|---|---|---|
| At level of operator's mouth | 1 | 0.13 |
| 1 ft. below | 1 | 0.31 |
| At level and 4 ft. to right | 2 | 0.10 |
| 1 ft. below and 4 ft. to left | 2 | 0.10 |
| 2 ft. below and 6 ft. to left | 1 | 0.24 |
| At level and 10 ft. to right | 2 | 0.066 |
| 1 ft. below and 11 ft. to right | 2 | 0.076 |
| 2 ft. below and 6 ft. to right | 4 | 0.11 |
| 1 ft. below and 3 ft. behind operator | 5 | 0.066 |

[1] The porcelain plates had an area of surface exposed varying from 12 to 50 sq. cm.

In the spray painting of small objects in a cabinet with good suction, no lead was found in the air samples collected outside the cabinet. (Table 3.) Though lead was present on the plates exposed to the escape of spray, it was

TABLE 3.—ANALYSIS OF AIR SAMPLES IN SPRAYING SMALL OBJECTS IN AN EXHAUST CABINET

| Position of Mouth of Collecting Tube | Mg. of Lead per 300 L. of Air | Mg. of Lead per 10 Cu. M. of Air |
|---|---|---|
| 1½ ft. from object sprayed, at level of operator's mouth, varying in position the full width of the exhaust cabinet, but exterior to the cabinet | 0.0 | 0.0 |

found in very small amounts in the cabinet at the level beyond the space where the operator's body goes. The largest amount was on the plate placed in the main line of beat back from the particular object sprayed. No lead was found on the plates exposed behind the operator's position. (See Table 4.)

Various masks were tested to see how much protection they offered from breathing in the lead-laden spray.

TABLE 4.—ANALYSIS OF DEPOSITS ON PORCELAIN PLATES IN SPRAYING SMALL OBJECTS IN AN EXHAUST CABINET

| Position of Plate with Reference to Operator | Distance in Feet from Object Sprayed | Mg. of Lead per Sq. Cm. of Plate Exposed for Half Hour Periods |
|---|---|---|
| At level of operator's mouth, exterior to cabinet | $1\frac{1}{2}$ | 0.002 |
| $1\frac{1}{2}$ ft. below and 3 ft. behind, exterior to cabinet | $4\frac{1}{2}$ | 0.00 |
| At level and $1\frac{1}{2}$ ft. to left of object painted, just within opening of cabinet | $1\frac{1}{2}$ | 0.004 |
| $1\frac{1}{2}$ ft. below and $1\frac{1}{2}$ ft. to left of object painted, just within opening of cabinet | $1\frac{1}{2}$ | 0.003 |
| $1\frac{1}{2}$ ft. below and in line of main beat back of spray, just within opening of cabinet | $1\frac{1}{2}$ | 0.018 |

[1] Plate area varied from 12 to 50 sq. cm. The amounts estimated for each sq. cm. are calculated from the amount found on each plate.

These tests were made either in the same room as those reported in Table 1, or in a room 10 by 10 by 9 feet. In each case a duplicate air sample as a control was taken without protection.

The ordinary masks provided for the painter consist of cotton-wool covered with one or two layers of gauze and, in some cases, having charcoal between the layers of wool. Such a mask is held in place by an elastic band. Another type of mask has a rubber facepiece covering the mouth and nose. The opening of this mask is covered with gauze and cotton-wool or with filter paper.

The results of our tests reported in Table 5 show that fine wire gauze masks are no protection whatever. A mask of gauze and cotton, as thick as possible without causing uncomfortable or strained breathing, reduced the lead present in 10 cubic meters of air from 90 to 10 mg. This is still, however, above Legge's danger line of 5 mg. per 10 cubic meters.

TABLE 5.—EFFICIENCY OF VARIOUS PROTECTIVE DEVICES TESTED DURING SPRAYING OF AN INSIDE WALL

| Air Samples Taken at Level of Mouth and Nose of Operator | Mg. of Lead per 300 L. of Air | Mg. of Lead per 10 Cu. M. of Air |
|---|---|---|
| A. Number 20 wire gauze mask | 6.25 | 208.0 |
| Control—no mask | 6.25 | 208.0 |
| B. A mask of gauze and cotton-wool of the maximum thickness allowing easy breathing | 0.31 | 10.42 |
| Control—no mask | 2.75 | 90.0 |
| C. A mask of gauze, cotton-wool, and activated charcoal manufactured by Bauer and Black | 0.1 | 3.33 |
| Control—no mask | 3.12 | 104.2 |
| D. A mask of gauze and cotton-wool of the maximum thickness allowing easy breathing and moistened with 5% sodium sulphide solution | 0.37 | 12.4 |
| Control—no mask | 6.98 | 232.2 |
| E. As in D | 0.17 | 5.853 |
| Control—similar mask without sodium sulphide | 0.34 | 11.706 |

The manufactured mask of gauze, cotton-wool and charcoal reduced the lead present below the danger line, but in order to do this all the air must pass through the mask. It was not found possible to wear this mask so that all the air breathed passed through it without discomfort and without straining inspiration. No workman would endure it. If worn comfortably, the mask is useless, for air comes in at the side of

the nostrils. The charcoal is unnecessary for the holding of lead pigment, but may be of use for volatile bodies. Any mask will become useless after a coating of paint is deposited on it.

Masks of comfortable breathing thickness moistened with 5 per cent. solution of sodium sulphide reduced the amount of lead present in the air breathed from 232 mg. per 10 cubic meters of air to 12.4 mg. A similar mask, but dry, allowed 11 mg. per 10 cubic meters to pass through. Both these results are still above the danger line. Sodium sulphide solution through which carbon dioxide was bubbled gave the odor of hydrogen sulphide, and the color reaction with basic lead acetate was soon lost. Sodium sulphide on a mask is not unpleasant, though at first the odor of hydrogen sulphide is noticeable. We found that there was an improvement when the mask was worn over a rubber facepiece, allowing an air space between the gauze and the skin. The skin became blackened, however, owing to the formation of lead sulphide, and was not very readily cleaned. The mask would need to be moistened every fifteen or twenty minutes to be as effective as in the test made. Ammonium sulphide was practically useless. Further, Carlson and Woelfel (11) have shown that lead sulphide itself is not free from danger as it is soluble in the gastric juice. Moreover, a certain amount of hydrogen sulphide would, of course, be absorbed and this is detrimental to health. Other solutions for moistening masks might be made from soluble sulphates or carbonates but they are likely to give only a false sense of security. It would appear that it is not possible for a workman to get enough air through a really effective mask of this type with any degree of comfort.

These experiments show that when lead is a constituent of the paint used in spraying walls inside a building there is danger of absorption of lead. Since much of the work is done in new buildings or in buildings where the industries do not ordinarily require suction ventilation, exhaust ventilation of fumes and spray would not be available. Consequently, the operator would have to depend on currents of air from open windows and electric fans and on the protection afforded by masks or respirators. In some paint work, however, a current of air is not desired on account of the too rapid drying of the paint. In exterior painting, there would likely be less risk from lead poisoning, as the painter could take advantage of the prevailing air currents.

There is no danger from lead poisoning when spraying small objects properly placed in an exhaust cabinet provided with efficient suction. The more common faults and imperfections in this class of work, as pointed out by Albaugh (12), are: (*a*) good cabinet, but exhaust absent or inefficient; (*b*) good exhaust, but cabinet too shallow; (*c*) good exhaust, but poorly located in cabinet; (*d*) fan too far from box; (*e*) exhaust inlet too small or pipe occluded by accumulations of paint, etc.; (*f*) cabinet not of proper shape to allow uniform draft; (*g*) tendency of operator to spray at right angle to flat surface, so causing the spray to roll back; (*h*) spraying too large objects and thus getting out of range of the exhaust; (*i*) spraying promiscuously about the room in testing the sprayer; (*j*) sitting on the stand inside the cabinet in order to rest while spraying; (*k*) defective vision of operator; (*l*) poor illumination of work space. Some of these defects were observed during this investigation.

The painter using a spray machine must observe the precautions necessary

for all types of painting, if lead is used —*viz.,* adequate washing, wearing of overalls, protection of food and street clothing from dust and spray, cleanliness of working clothes, the avoidance of tobacco and of the placing of articles in the mouth during working hours. The writer, after using a spray painting machine, has thoroughly washed his hands and arms with hot water and soap and a nailbrush, and has still been able to find a definite blackening with sodium sulphide solution. Amounts varying from 2.79 mg. to 602.64 mg. of lead monoxide were found in the dust removed from clothing by beating, and in the dust in pockets of overalls (13).

But the spray painter, more than other painters, is exposed to another risk which requires investigation. This is the inhalation of fumes of volatile products used in the paint, such as turpentine, benzine, benzol, and possibly linseed oil and driers. These, as Goadby (4) says, are known to produce respiratory effects in susceptible animals. He further states that the constant inhalation of vapors of volatile fluids is conducive to renal affection and high arterial tension. The workman may be ignorant of the presence of these poisons and the dangerous character of the work. Not many painters, however, would connect a kidney disturbance with the turpentine with which they work, nor would they recognize chronic bronchitis as a hazard of their trade. Moreover, many of them accept their ailments as a necessary evil. Goadby's experience is in accord with that of Oliver (5) who found that animals exposed to the vapor given off from freshly painted surfaces suffered in health as did also animals exposed to the vapor of turpentine. At the autopsy he found the lungs engorged and the tubular epithelium of the kidneys the seat of cloudy swelling.

None of the painters interviewed during this investigation gave a history of symptoms pointing to the vapors of volatile fluids, but their failure to do so may be explained by the fact that they were practically all protected by exhaust cabinets. A special investigation has, however, been undertaken by this department which, it is hoped, will contribute valuable information on the effects of the volatile bodies of paint.

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# SHERIDAN DELEPINE

*Late Director of the Public Health Laboratory and Professor of Public Health and Bacteriology, Victoria University of Manchester, and Associate Editor of the Journal of Industrial Hygiene.*

[The death of Dr. Sheridan Delépine has removed from our midst a pioneer in the science of research into industrial hygiene, and from the staff of the JOURNAL one of its original associate editors, the first whose death we have had regretfully to record. Some appreciation of the man and of his work, contributed by Dr. T. M. Legge, who was well acquainted with both, is here given.—*E. L. Collis.*]

An appreciation of a man and his work should take account of the circumstances in which he found himself placed, of the difficulties which he had to face, of how he overcame them, and of the mark which he has left behind.

The phase in Delépine's work which alone I propose to touch on is the part which he played in trying to animate public health work by his sympathy, indomitable industry, and, above all, by a strictly scientific spirit. On the fly-leaf of his first Report as Director to the Advisory Committee of the Public Health Laboratory in 1902, he has inserted this quotation from J. A. Froude:

> We may make our own opinions, but facts were made for us; and if we evade or deny them, it will be the worse for us.

This power of his to deal with facts and let them tell their own story as brought out by laboratory investigation, was his guiding principle. In the addresses which he gave from time to time assuming the standpoint from which at the moment he regarded the position of public health, he constantly harped (and I use the word in the literal and not the accepted sense) on this point:

> The object of the D. P. H. course is not to produce a few expert scientists, but chiefly to train an adequate number of officers, capable of appreciating the value of the assistance which they may derive from science in their administrative work, and of taking an intelligent and practical interest in the work of the chemists, bacteriologists, veterinarians, engineers, statisticians, lawyers, etc., also engaged in work closely connected with that of the medical officer of health.

While having this confident belief in the future of public health work, provided the assistance which science could bring to the administrative side were always kept prominent, he was never under the delusion that money was to be made in it, but he felt that the opportunities for research and philosophical thought were more than an adequate compensation.

We may take his first Report as Director of the Public Health Laboratory as a sort of midway point in his career behind which, from 1882, was the work of preparation by attention to the diagnosis of disease by laboratory methods, and afterwards—he was appointed Professor of Pathology at Owen's College in 1891—the fruition and practical application of his knowledge by placing the resources of his laboratory at the disposal of all medical men and some 120 sanitary districts, including Manchester, Salford, and the great Lancashire industrial area.

This was the first instance of the kind in which the scientific side of a university linked itself up directly with municipal activities of a medical nature. The number of specimens examined in 1902 was 5,165, or a daily average of 14, whereas in 1921 it had increased to 19,539, or a daily average of 53.5. The work grew so vast that it led to the erection of a special Public Health Laboratory (Delépine himself designed the buildings) and the creation of a special department with special provision made for teaching the various branches of public health for the diploma in that subject. This was the home from which all the subsequent

*Born Jan. 1, 1855; died Nov. 13, 1921. He was the eldest son of Antoine Delépine of Paris, a man of wide outlook and culture and a very original thinker, to whose wise upbringing he owed a great deal.

activities of Delépine and his busy staff emanated. Now in most large towns a municipality has its own laboratory, but hitherto Manchester and the great surrounding industrial district have relied on his laboratory.

Delépine was a man of meticulous detail —too much, I sometimes thought—and the sight of his immense maps of the farms in the counties from which Manchester and Salford drew their milk supplies, with dots all over them in different colors showing the number of farms in which tuberculous milk was found, was bewildering. Similarly, the soft moorland water from which the district derived its supply was always kept under the closest supervision from the plumbo-solvent and erosive points of view. Others, however, are more fitted to deal with the purely public health side of his work. I confine myself here to the pioneer work which he did in factory hygiene.

His signal service in this respect was the recognition of the importance of factory hygiene. Manchester University was the first—and, to the shame of the other teaching universities in Great Britain and Ireland, except recently Cardiff—still is the only one including instruction in this subject as an integral part of the course for the Diploma of Public Health; I do not count of value what the full-time Medical Officer of Health, an administrative officer divorced from the practice of medicine, can say about it. Yet Delépine, to effect this change, only utilized the powers given by the General Medical Council of shortening to three months (provided certain special courses were given) the often time-wasting requirement of attendance for six months' practical work with a Medical Officer of Health. I have before me now correspondence in the year 1910 about this change, in which he insists on the differentiation in the general course covering the duties of *all* Medical Officers of Health and the special course on factory hygiene, for which he wisely provided a separate examination of an honors standard and a special certificate. Quite rightly he never regarded factory hygiene as anything but a branch of general medicine and surgery and, therefore, a matter for the general practitioner to know about rather than an administrative officer, but, failing the possibility of teaching the general practitioner, he saw the advantage of the Medical Officer of Health having, at any rate, a smattering.

Delépine was always interested in industrial problems and placed his knowledge and inventive genius in laboratory methods to great use in the helpful elucidation of such problems. Thus, in the great beer poisoning epidemic from arsenic in 1900, in which several thousands were affected, it was Delépine who, after Reynolds had discovered arsenic in the beer—Delépine had already guessed it—traced the arsenic to the glucose used by the brewers. For the Royal Commission which investigated the circumstances of the outbreak, Delépine not only was the first to show how effective in helping to diagnose arsenical poisoning was analysis of the hair for the metalloid, but also devised quantitative methods of analysis, which are today in constant use. This hydrochloric copper (Reinsch-Delépine) method was used in determining the amount of arsenic found in the fatal case of industrial poisoning by arseniuretted hydrogen, published in the JOURNAL OF INDUSTRIAL HYGIENE.* This was the only article which he contributed, as his health was already failing at the time the JOURNAL was started, but it is a good illustration not only of his skill in chemical analysis but also of his skill as a morbid anatomist and microscopist.

Another inquiry showing his gift for turning his scientific knowledge to practical purpose, a gift also possessed by Haldane, was his paper in 1911 on "The Pathogenic Properties of the Gases Discharged by the Exhaust Pipe of Gas Engines." Even now cases of carbon monoxide poisoning are sometimes called petrol poisoning, but how common carbon monoxide poisoning from this cause may be under bad working conditions even at the present time! When visiting a factory for the assembly of motor cars in the United States, I was informed by the plant physician that recently on a dull morning he had treated eighty men suffering from slight effects of carbon monoxide. But it was original research when Delépine, after many experiments on internal combustion engines, arrived at his conclusions that:

*Delépine, S.: Report on Certain Organs in a Case of Fatal Poisoning by Arseniuretted Hydrogen Gas. JOUR. INDUST. HYG., 1919-1920, *1*, 356.

The main cause of danger when my experimental gas engine was overloaded was the considerable reduction in the amount of oxygen contained in the exhaust gas: the proportion of carbon dioxide was also very large. The danger began to be rapidly manifest when the quantity of exhaust gas exceeded 50%.

The main cause of danger when the supply of air to my experimental gas engine was insufficient was the presence in the exhaust gas of a large amount of carbon monoxide. This danger began to be manifest when the proportion of exhaust gas reached 1 part of gas to 40 or 50 parts of air. The CO present in the exhaust gas is partly derived from the unburnt coal gas, and partly from the imperfect combustion of the gas that is utilized. It is probable, therefore, that the use of power gas is attended with greater danger than the use of ordinary lighting gas. Anything blocking slightly the entrance of the air pipe is sufficient to bring about this danger.

Lastly, the subject of anthrax appealed to him, and in the epoch-making researches carried out by the Home Office Sub-Committee into the "Duckering" method of disinfection of wool (preliminary washing in warm alkaline solution, passage through rollers, and subsequent immersion in warm $2\frac{1}{2}$ per cent. solution of formaldehyde) he kindly acted as the "control," throwing himself with zest into the inquiry and adding the weight of his authority to the final demonstration of the success of the method. Many years previously he had perfected a method of current steam disinfection both rapid and sure, and it was with some regret, I remember, that he satisfied himself that this would not do for wool.

This, in briefest outline, indicates the wide range of his activities. In his big, generous presence one felt that here was the master mind. And yet, perhaps, because his early life had been passed on the Continent, his meaning was not always easy to grasp at first, and I have often smiled at the recollection that my first acquaintance with him arose through a misunderstanding—by my thinking that he belittled the efforts made to use Sclavo's serum in the treatment of anthrax in the human subject, and I was surprised at the pains which he took to remove the erroneous impression. Again, when the question of a medical referee on industrial diseases under the Workmen's Compensation Act arose for the industrial area of Lancashire, knowing how busy he was, I suggested that one of the assistants, Dr. A. Sellers, should be appointed, but the proposal conflicted with his views of the status which, as Director of the Laboratory, he felt he must hold, and so the difficulty was happily solved by appointing both to the one position. Possibly this difficulty in understanding him readily, but more probably his directness, his sensitiveness and the absence in him of any trace of self-pushfulness accounted for the fact—a source of surprise and poignant regret to his friends—that wide public recognition of his achievement never came to him. But as one of his colleagues said years ago to me, "Though he may be difficult to understand, few, when they grasp his meaning, do not think him right."

I happened to hear of his death when in Geneva, a town which in his youth he must have known so well, and I could not help thinking that few can have repaid the teaching received there and at Lausanne better than did Sheridan Delépine.—*T. M. Legge.*

## BOOK REVIEWS

Lead Poisoning in the Pottery Trades. By Bernard J. Newman, William J. McConnell, Octavius M. Spencer, and Frank M. Phillips. U. S. Public Health Service, Public Health Bulletin No. 116, May, 1921. Pp. 220 with index. Washington: Government Printing Office, 1921.

In December, 1918, the Brotherhood of Operative Potters requested the Department of Labor and Industry of Pennsylvania to investigate pottery making in order to determine the prevalence of lead poisoning among dippers. The union felt that the discrimination by the industrial insurance companies against many men employed in the pottery industry, in particular against the dippers, was unjustifiable, and that a survey would show that the hazard of these occupations was not nearly so great as was supposed. Their request was forwarded to the U. S. Public Health Service, and with the approval of the Surgeon General the inquiry was begun. The results have just been published.

Two earlier studies of this same industry are reviewed by the authors, one made by myself for the Bureau of Labor in 1911, and one made by Dr. E. R. Hayhurst in 1914. The present investigation was far more extensive and complete than either earlier one, and the findings are therefore much more authoritative. Not only was a thorough survey made of more than half the potteries in the country but the study of plant conditions was supplemented by estimations of the quantity of dust in the air of dipping, mixing and kiln rooms, and the amount of soluble lead in the dust. The determination of the rates of lead poisoning among pottery workers was made by physical examinations of 1,809 men and women whose work brought them in contact with lead compounds. The publication is one that reflects great credit on the Public Health Service, but not on the pottery manufacturers, for the conditions revealed are, according to all foreign standards, very bad indeed, and it is discouraging to one who remembers the state of the industry in 1911 to realize on reading this report that there has been little if any improvement during the intervening years, the most crying evils have apparently been quite unaffected by federal and state investigations and admonishments.

The authors say that there is an impression generally held by manufacturers that it is impracticable to install improvements in the plants, since the industry is bound to decline, yet as a matter of fact in a little over sixty years the number of potteries in the United States has increased almost a thousand per cent., and the increase in imported china has not kept pace with the increase in population, pointing to "a permanency which warrants serious consideration of the character of the health hazards and of means to minimize them." Another excuse commonly given for poor plant hygiene is that most of the potteries are small and not much can be demanded in the way of control of hazards, but this also the authors find not borne out by the facts. Of the ninety-two potteries visited sixty-two employed from 100 to 250 persons, and nineteen employed up to 500.

The United States Potters' Association, an organization of potters manufacturing vitreous china, sanitary ware and earthenware, makes regular working agreements with the employees' organization, the National Brotherhood of Operative Potters, and as a result of this arrangement the industry has been free from strikes for a long period.

The Public Health Service inquiry covers 92 plants in Ohio, New Jersey, West Virginia and Pennsylvania. The Ohio pottery field is much the most important, and the West Virginia field is closely bound to it. Of the 26,705 persons employed in 1914, 11,096 were in Ohio. These 92 plants comprised 21 manufacturing sanitary ware, 59 "general ware"—*i. e.*, table and toilet ware—4 yellow ware, 4 art ware, and 4 tiles. "The buildings are mostly makeshift structures, ill-adapted to the processes, although a few were found of modern type. In the older buildings little attention was given to the convenience, comfort or health of the worker. . . . An effort toward improvement was found in plants built during the last decade, although these efforts often failed because of lack of full appreciation of the problems offered by the processes involved." These processes are the ones with which a lead hazard is connected, namely, washing or painting saggers (earthen boxes in which the ware is fired) with lead

glaze; mixing lead glaze (no leadless glaze was found in use); dipping; kiln work; and decorating.

In Great Britain all potteries using a glaze with as much as 5 per cent. soluble lead* come under special rules, as to the structure of the departments mentioned above, as to the provision of working clothes for employees, the provision of washing facilities and their enforced use, of lunch rooms and their enforced use, and of regular medical examination of all men and women employed in the lead work, with notification to the Home Office of all cases of plumbism found. The rooms in which these processes are carried on must have smooth impervious floors, flushed at the end of the day. Scattering of dry or wet glaze is prohibited. Removal of excess glaze must be done before an exhaust, and the glaze caught in water. All boards, racks, and benches, on which glazed ware has stood, must be wet-cleaned at the end of the day. No dry sweeping or dusting is allowed. At the lunch hour the workroom must be left, the employee must divest himself of working clothes, scrub his hands and nails in warm water, wash his face, rinse his mouth, and go to a lunchroom which is the only place where he is allowed to leave his dinner pail. His working clothes, including cap or sunbonnet, are provided, laundered and repaired by the employer. Once a month an inspection of each worker is made by a physician and if signs of lead absorption are noted the management is warned. If lead poisoning is found, work with lead must be suspended. The carrying out of these provisions has been admirable, and the potteries of the Staffordshire district are as free from lead dust as it is possible to make them.

A great contrast is found in the plants visited by this commission. In the first place, the glazes are rich in soluble lead. Of 107 samples which were analyzed, 73 per cent. contained from 10 to 20 per cent. soluble lead. Eleven had from 20 to 50 per cent. The English often "frit" the lead, that is, add the lead to the other ingredients and fuse them together, by which fusion much of the lead changes to the insoluble disilicate. This is not customary in the United States although apparently the authors found it done in some potteries. The usual method is to add white lead to the fritted mass.

*Lead passing into solution after two hours' agitation with 0.25 per cent. hydrochloric acid.

In mixing the glaze, much dust is formed. The authors found a higher dust content in the air in the mixing rooms than in any other department, but more soluble lead in the dripping rooms. Here the dust comes from the drying of splashed glaze on floors, benches and walls and from the accumulations of glaze dust on ware boards and racks. Handling these boards, dropping them frequently down on end, sweeping the floor and the passing to and fro of kilnmen and ware gatherers, all keep the dust stirred and the air contaminated. Glost-kiln placers not only handle the glazed ware but rub off the excess from the feet of the ware, often against their aprons. Here, too, the benches and the floor are covered with glaze dust.

In 47 of the 92 potteries, sweeping was done during working hours, and in 25 of these the floors were swept dry or only slightly sprinkled. In not one single plant was a separate, modern washroom provided for the use of the employees. The facilities for washing were as follows: hot water, 20; soap and towels, 4; troughs of some type, 29; pails of water, 37; other forms, such as tubs, 9. "In many of the plants the workers wash either in basins removed from the racks or in troughs used for washing the ware and ware boards," but as the glaze from these troughs is collected for further use, the workers are not allowed to wash with soap because the soap would ruin the glaze. Yet the faucets over these troughs may be the only ones available. "In quite a number of plants the dippers and dippers' helpers are known to wash their faces and arms with the sponges which are used to clean the sides and edges of the dipping tubs. In general, the washing facilities are scanty and inadequate, and because of this condition the employees wear their work clothes from the plants to their homes." The description goes on, in much the same vein, with regard to the care of street clothes—1 plant only possesses a locker room; in 66 the clothes hang in the workroom—with regard to the provision of drinking water—19 with pails only, 18 with pitchers only—the discovery of individual drinking cups hanging so as to catch lead dust and of uncovered pitchers of coffee and of water standing on shelves, often with a scum of dust visible

on the surface of the liquid. In only 22 of the plants do the employees wear any sort of protective clothing, in the others all clothing is worn home after work. The employer has no concern whatever with this detail, neither providing clothing nor a place in which to don it, nor insisting that the employee provide it. In only 5 plants were there regulations against eating lunch in the workrooms, and in 3 these were not observed. In 80 plants some workers eat in these rooms and in 65 the majority do, that is, about 969, or one-half of all those examined in the survey.

As to medical supervision, it does not exist, except for an attempt at it in one of the 92 plants. No examinations of the workers are made, no effort is made to diagnose lead poisoning in its early stages, there are no company hospitals, and only two dispensaries. As no effort is made to instruct the workers regarding the proper ways of preventing lead poisoning, it is not strange that superstitions persist among the pottery workers, such as the efficacy of tobacco chewing to carry off lead dust, and the beneficial effect of getting drunk and vomiting the accumulated lead once a week.

In view of the conditions described above the examination of specimens of dust becomes very interesting. They were collected from three departments—glaze mixing, dipping, kilns—and two from other localities. Collections were made with the Palmer machine and 293 specimens in all were secured. Assuming that the number of Class 4 particles per cubic foot of air should not exceed 200,000, the investigators found that only 25.6 per cent. of the specimens were as dust-free as that, while 26.8 per cent. showed from 200,000 to 500,000 particles per cubic foot of air, and 47.8 per cent. would be regarded as excessively dusty, containing over 500,000 particles. Thirty per cent. of these last had 1,000,000 particles or more. The highest counts were found in the glaze mixing rooms where 15 out of 41 samples fell in the 1,000,000 column. The soluble lead in the dust was then estimated. Eighty-nine specimens showed from 10 per cent. to 49.9 per cent. soluble lead, and 9 more than 50 per cent. The largest proportion was found in the dipping room specimens, 55 out of 90 of which had from 10 per cent. up.

The pottery workers are to a large extent American-born, and if of foreign birth, chiefly English. Of the 1,809 workers selected for examination, 1,436 were men, 373 women. Only about 8.4 per cent. of all the employees in the potteries are exposed to lead, and it was from this minority that all individuals were drawn. The men were chiefly glost-kilnmen and dippers; the women, dippers' helpers and ware cleaners. Men are far more exposed to lead than are women—79 per cent. of those examined were men. The turnover for men is high during the first few months of employment, after that rather low. Seventy per cent. of the dippers and 65 per cent. of the glost-kilnmen had been employed more than ten years. The women average much younger than the men and their turnover is high.

Great caution is used by the authors in making a diagnosis of lead poisoning, and the cases are grouped under three heads—positive, presumptive, and suggestive—although in the opinion of the examiners these different diagnostic groups simply represent different degrees of plumbism, and the first two may, for all practical purposes, be considered together. The discussion of the symptom-complex which may be considered diagnostic is interesting, and the authors suggest that a standard terminology, such as used by them, be adopted in future surveys and in analyzing existing records so that a comparison of the data obtained from various sources may be made. Briefly stated, their findings are as follows:

Positive and presumptive lead poisoning was found in 13.5 per cent. of all cases, the men having a rate of 14.2, the women of 11. If the third group, containing suggestive cases, were divided evenly between the positive and negative, the rate would be 22.8 per cent. for all, with 23.1 for men and 21.5 for women. This last estimate seems sufficiently cautious and conservative in view of the description of these so-called suggestive cases. They are workers exposed to lead who exhibit some combination of the following symptoms: constipation, loss of weight, loss of strength, drowsiness, pain in lumbar region, pain in joints, headache, insomnia, confusion, loss of morning appetite, metallic or sweetish taste.

Age, or rather, perhaps, length of exposure, has some influence on the occurrence of lead poisoning. The positive cases among

the men averaged 44.3 years of age, the negative 37.5 years. The low rate of plumbism for women as compared with men is only apparent, for when one estimates the length of exposure of the two sexes and compares the rates for men and women engaged in the same sort of work, it becomes apparent that the women are actually more susceptible. The average length of exposure of the positive male cases is 17 years, of the female cases 9.9 years, while for the two presumptive groups the figures are 15.7 and 6.3. "It should also be mentioned that in most plants the length of day for the female worker is from one-half hour to one hour shorter than that of the male worker. It would seem that the female reaches these stages of lead poisoning in about half the time required for the male to reach them." Comparing the men and women who work side by side in the dipping rooms, it was found that 58 male ware carriers had no positive cases of plumbism, while 62 women ware carriers had a rate of 4.8 per cent. The women, however, had been exposed a slightly longer period of time. Among 71 male dippers' helpers the rate of plumbism was 8.4 per cent., and among 149 female dippers' helpers, the rate was 14.4 per cent.

It would require too long to go into the details of the studies of weight, blood pressure, pulse rate, dynamometer readings, etc., but a few words must be said as to the influence on the incidence of plumbism, of such factors as high percentage of lead in the glaze, neglect of ordinary hygiene, lack of washing facilities, use of the workroom as a lunchroom, and the length of the working day. The rate of positive plumbism for those working seven hours a day and less is 7.9; for those working eight hours, 9.8; for those working nine hours, 6.5; and for those working ten hours or more, 11.2. Those working on a nine-hour schedule are in occupations slightly less hazardous than those employed for the other lengths of day, and those plants in which the nine-hour schedule prevails have fewer bad conditions. As to the quantity of lead in the glaze, the rates for the plants using glaze with more than 12 per cent. soluble lead were 17.6 for the men and 14.8 for the women, while in those using less than 12 per cent. soluble lead the rates were 6.8 and 2.7. Grouping the plants according to ordinary factory hygiene, it was found that the eight worst potteries had a rate of positive and presumptive plumbism of 34 per cent., while twenty-nine plants with better conditions had a rate of only 6.3 per cent.

It may perhaps be of interest to insert at this point the last full report of the British Factory Inspection Department concerning plumbism in the potteries. This is for the year 1913, the last year for which rates of poisoning are available. In this year there were found 62 cases of plumbism among 7,085 employed, making a rate of 0.9 per cent., the rate for women being 1.0 per cent., and for men 0.8. The dippers had the highest, 2.4 per cent. It seems probable that even this excellent record has been improved during recent years, for there were only 21 cases reported for 1919, but the number of persons employed is not given and therefore one cannot be sure.

In their summary, the authors aproach with extreme caution the question of responsibility for the conditions leading up to this excessive rate of plumbism in American potteries. Indeed, they may be almost said to lean backward in their effort to be impartial. Admitting that the amount of plumbism seems to depend upon the various amounts of soluble lead used in the glazes and upon unhygienic conditions found in the plants, they declare themselves unwilling to say whether or not the incidence of lead poisoning is to be charged to plant conditions more than to the personal habits of the employees. This is a little difficult to understand in view of the statement made on the following page that little if any instruction is given the pottery worker concerning the danger he faces and the precautions he should use; in fact, it seemed to the investigators that those in charge of the plants were "either indifferent or careless or ignorant in regard to lead hazards." Nor does it seem fair to include "length of exposure" as one of the "personal" factors in lead poisoning. Even the reckless habit of eating with lead covered hands cannot, in all instances, be regarded as a charge against the workman if the only water provided him for washing is a thin suspension of lead glaze.

All foreign countries in which industrial

hygiene is taken seriously have found that the only practical way of enforcing proper sanitary control is to throw the responsibility upon the employer. The question is not one of moral judgment, but of a practical working method. It is quite as useless to expect a man of careful, cleanly habits to protect himself from lead poisoning in a pottery as to expect the individual city dweller to protect his own family against polluted water and milk and against communicable disease. We shall never get rid of industrial poisoning in the United States until we begin to deal with it as we do with such community diseases as malaria, hookworm, and typhoid fever—that is, by instruction of the individual in the nature of the hazard and the proper means of protection against it, and by community control of sources of danger. —*Alice Hamilton.*

# SUBJECT INDEX TO VOLUME III

This is a subject index to all the reading matter in the JOURNAL OF INDUSTRIAL HYGIENE, and one should, therefore, look for the subject word, with the following exception: "Book Notices" are indexed under this title on page 397. The name of the author follows the subject entry in parentheses.

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## BOOK NOTICES

# AUTHOR INDEX TO VOLUME III

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

SUPPLEMENTARY TO

THE JOURNAL OF INDUSTRIAL HYGIENE

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# ABSTRACT OF THE LITERATURE
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## CONTENTS



## GENERAL

INDUSTRIAL DISEASES. *T. M. Legge.* Great Britain Ann. Rep. Chief Inspect. Factories and Workshops for the Year 1919, 58 68. — Periodic examinations have been instituted for briquette makers with special reference to regular medical examinations for early detection and prevention of cancer.

*Welfare Orders.* — In fruit preserving, oil cake mills, gut scraping, etc., questions of first-aid equipments for special needs of each industry have been referred to the medical inspector of factories. Dr. Bridge has inquired into skin effects of orange peelers and gut scrapers, also of workers in manufacture of clinical thermometers, and has dealt with the difficulties encountered by first aid and ambulance orders. He has inspected effects of temporary blindness from electric welding, the effect on women of the "Oliver" Forges, dust in silk manufacture and poisoning from industries using arseniuretted hydrogen. The branch investigating the employment of women and children in unhealthy occupations, lead, anthrax infection, and carbonic gas poisoning, concluded that pregnant women should be debarred as maternity is affected by lead. Where lead fumes and dust are excluded, women may be employed. "Carrotting" fur with mercury solution is under consideration. Wool should be disinfected for spores of anthrax at the port of entry, and universal factory inspection is recommended. Hereafter, to notifiable diseases will be added epitheliomatous ulceration from tar, pitch, bitumen, mineral oil or compounds or residues, and chrome ulcer. Useful information appears as follows.

*Epitheliomatous Ulceration.* — Raw surfaces properly treated heal quickly, except in handlers of tar, pitch or paraffin, in persons past the third decade of life and especially in those who have worked in these substances for ten years or longer. Such ulcers spread broadly and deeply and demand notification as skin cancer. They occur frequently on the scrotum.

*Chrome Ulceration.* — Chrome produces eczema or circumscribed ulcers, "chrome holes," and both these conditions are reportable.

*Lead Poisoning.* — This increased in 1919

owing to the return from army to ordinary trades. Lead poisoning is now greatest, not from manufacture of white lead, pottery or coach painting, where it is prevalent enough, but from electric accumulators, especially in "pasting." This process should be done entirely by pasting machines, at present employed only in the larger works, for hand pasting is very dangerous. Exhaust ventilation is required in lead burning and wire brushing departments. Examination of 25,000 reports leads the author to the conclusion that exhaust ventilation is the only protection from dust and fumes. Many fatalities are arteriosclerotic, general, or specially localized in brain, kidneys, etc., resulting from poisoning many years earlier.

The International Labor Conference recommends that, due to dangers to maternity and child development, women and young people *below 18 years* be excluded from: (1) furnace work in reduction of zinc and lead ores; (2) any handling of ashes containing lead and in desilverizing of lead; (3) melting lead or zinc ores on a large scale; (4) manufacture of solder or alloys of over 10 per cent. lead content; (5) manufacture of litharge, massicot, red, white or orange lead, sulphate, chromate or silicate (frit) of lead. It is also recommended that women and persons below 18 years be permitted to work in lead on the condition that provision is made for: (1) local exhaust ventilation; (2) clean tools and workrooms; (3) notification to government authorities of all cases of plumbism with compensation; (4) periodic examinations; (5) suitable cloakroom, washing and messroom accommodation, and special protective clothing; (6) no food or drink to be taken into the workrooms.

*Phosphorus and Arsenic Poisoning.* — The former is rare; the latter more frequent. An additional safeguard is a valve feed for ice such as the one used in one reduction plant, where cases of poisoning were reduced to *nil.* Large arsenic output from the urine of men without symptoms was found in many patients using arsenic containing vessels.

*Mercury Poisoning.* — Three cases occurred in the manufacture of philosophical instruments, two in the manufacture of fulminate of mercury, and two in a certain smelting process.

*Toxic Jaundice.* — All three cases occurred from T.N.T., and all proved fatal. One case is reported of atrophy of the liver eight months subsequent to cessation of work; another had headache, dyspnea, weakness and vomiting, with dermatitis of hands, and cyanosis; a third necropsy revealed fat necrosis of liver and purpura of the trunk and extremities.

*Fumes and Gases.* — Study here brings out the need of rescue appliances *always ready for use by the worker;* the dangers of working alone; and lastly, the great risks taken by rescuers. Carbonic oxide gas is the greatest hazard, but blast furnace gas, power and suction gas (as in charging the producer plant), coal gas, and coke fumes also take their toll.

*Anthrax.* — A table is inserted including all the cases of anthrax during 1919.

*Dermatitis.* — Cases were investigated among men engaged in wire drawing by hand; inflamed palms and circular ulcers, known as "soap holes," were found. The wire is lime coated to prevent rusting and this, with constant friction, induces inflammations which can easily become infected. Dermatitis from zinc chloride used as flux was investigated. Carelessness of operatives was responsible for a great number of cases. Dermatitis occurred in the use of coal tar dyes, formic acid and essential oil, in the preparation of toilet soaps. — F. Fremont-Smith.

Industrial Hygiene as a Factor in Production. *Bernard J. Newman.* Ann. Am. Acad. Pol. Sc., Sept., 1920. — Attention is called in this article to the experience of ordnance and similar plants in maintaining and increasing production by improving working conditions. In many plants, which at first looked upon industrial hygiene askance, experience demonstrated that this sort of work was not only desirable, but essential after it had once been undertaken. Several cases are cited showing how the elimination of industrial health hazards tended to reduce turnover and absenteeism due to sickness and other causes.

Health, comfort, and contentment are very active factors in production. In order to produce to his maximum capacity the worker must be physically fit. Where initiative is involved the element of mental alertness is especially important, and this to a considerable extent depends upon the physical condition of the worker.

Besides mere physical capacity other factors definitely related to hygiene are involved in production. (1) Fatigue improperly regulated leads to the accumulation of waste products which act as toxins. At the same time the accident rate tends to increase. (2) Orderliness

in a plant has a definite relation to uncleanliness and slovenly workmanship. (3) Unpleasant odors, distracting sounds, and extremes of temperature all tend to decrease the worker's effectiveness, often without developing any marked physical incapacity. Not only do these factors influence production within a plant, but they also attract a poorer class of workmen and lead to a higher percentage of labor turnover.

The development of a satisfactory policy for carrying on industrial hygiene in a plant demands a high degree of technical knowledge. As far as possible new plants should be built with a careful view to their hygienic qualifications just as they are built with a view to their production qualifications. Such aids as job analysis should be called to the assistance of the supervisor of hygiene within the plant. He should be interested not only in the elimination of hazards but also in the proper placing of workers so that their physical capacities will be accurately correlated with job requirements. — C. H. Paull.

Preventive Medicine and Hygiene in Relation to Colleges. *R. I. Lee.* Abstracted as follows from Boston Med. and Surg. Jour., Dec. 30, 1920, 183, No. 27, in Jour. Am. Med. Assn., Jan. 22, 1921, 76, No. 4, 269. — "Lee believes that while our standard methods of preventive medicine with which we are all familiar can be perfected considerably, nevertheless, not much more is to be expected of them. Already, in consequence of competent medical advice, there is only an occasional inevitable death from such conditions as appendicitis, mastoid, etc. At the present time local sanitary inspection and public health measures largely guarantee the purity of water and milk and tend to eliminate typhoid fever. It is for these reasons that Lee suggests strongly that more emphasis should be laid on instruction in hygiene and the systematic endeavor to attempt to establish in the population of all communities adequate health habits." — M. C. Shorley.

Occupation and Public Health. *A. Gottstein.* Abstracted as follows from Volkswohlfahrt, 1920, No. 7, p. 134 by C. Guenther in Hyg. Rundschau, Aug. 15, 1920, 30, No. 16, 505–506. — "The author emphasizes the importance of occupational advice — a new branch of industrial science in process of development, concerned with the securing of proper methods of determining qualifications for occupations, in which quickness of mind and special activity of the sense organs are concerned. With the suitable selection of occupation and the exclusion of the unfit from certain lines of work, much disaster, both physical and mental, can be prevented. Naturally, the question of suitability of work plays a large rôle with men whose health is permanently impaired from some illness or defect. Further, those cases deserve special attention, in which the man suffering with a disease of long duration is a public menace (active tuberculosis, syphilis). The dangers to health inherent in occupations occur in a large variety of pursuits: dust formation, changes of air pressure, temperature, humidity, and loud noises may be harmful; here also belong the danger to the eyes of workers from fire and light, the manifold injuries by chemicals, such as phosphorus, lead, mercury, arsenic, chlorine, etc., and further injuries due to animate causes of disease (the splenic fever of tanners). It is often difficult to judge the cases in which a real or alleged industrial disease undergoes a more rapid or a less favorable course due to an accident." — E. L. Sevringhaus.

Diseases and Stigmata of Broom Makers. *P. Piccinini.* Il Lavoro, Sept. 30, 1920, 11, No. 5, 135–142; Oct. 31, 1920, No. 6, 166–169. — The author concludes as follows:

1. Broom makers frequently develop dermatitis caused by mechanical irritation which sometimes becomes eczematous and, in many cases, presents the character of occupational lesions.
2. The distribution of callosities depends on the peculiarities of the employment.
3. Except for a very common conjunctival catarrh there is no special affection of the eyes.
4. Acute inflammation of the upper respiratory passages is fairly frequent, and chronic bronchial catarrh is not rare, but there is no evidence of industrial tuberculosis. There is, however, a mild transitory febrile affection which is industrial in origin.
5. The morbidity of broom makers is influenced by their work and surroundings, but is serious only in exceptional cases. — Alice Hamilton.

Department Store Hygiene. *A. B. Emmons, 2d.* Survey, Dec. 25, 1920, 45, No. 13, 463. — On December 1, 1919, the Harvard

Mercantile Health Work was started under the supervision of the Harvard Industrial Hygiene Division. The field of this work includes: (1) the environment of the worker; (2) fitting the worker to suitable tasks; and (3) medical care and health education for the worker. It is only a matter of time when the same attention will be given to the health of store employees as is now bestowed upon the health of industrial workers. This movement is founded upon the frank basis of increased production and good business policy. — L. A. Shaw.

Adult Working-Class Education in Great Britain and the United States. *C. P. Sweeney.* U. S. Bur. Labor Statis., Bull. No. 271, Aug., 1920, pp. 101. — A plea for the more liberal and intellectual education of the adult workman. Hitherto continuation and night schools have been mainly vocational. The workday must be made uniformly by law an eight-hour one, and in some especially hard trades, of even shorter duration. Give the workman a little leisure in which to think and study. — M. Dent.

## SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

### MENTAL

The Mental Hygiene of Industry. *Mary C. Jarrett.* Ment. Hyg., Oct., 1920, 4, No. 4, 867–884. — Miss Jarrett's report of the work undertaken under the Engineering Foundation of New York on the mental hygiene of industry is, on the whole, encouraging. Employers and, in some cases, labor organizations are beginning to realize that the problem of individual adjustment in our highly specialized modern industrial life is one to be dealt with and that it is a problem with which they are incompetent to deal without the aid of trained experts.

The workers in a particular plant are divided into three definite classes: (1) a very small group of employees, with actual mental disease; (2) nearly half the workers, with some mental or nervous peculiarity to be adjusted; (3) the largest group, possibly more than half, whose general efficiency can be materially developed and stimulated. Employers will readily acknowledge the application of mental hygiene to the first group and they are beginning gradually to see it for the second group. If it can be demonstrated that it is applicable to the third group, the results may be very far-reaching.

Miss Jarrett has done work in the Psychopathic Hospital and she also cites cases from her personal investigations in twenty-five centers of industrial work in thirteen cities, in which often the best workmen would gradually or suddenly "fall off" in the quality of their work, or would become undependable and take a day off whenever the spirit moved them. In every case she found either a family difficulty or some mentally unhygienic working condition which could be straightened out by personal direction and tact.

"Gradually all points of view from which industry is studied — economics, medicine, engineering, labor, capital — are coming to a focus upon the basic fact that production rests upon mind. Mental power is the greatest force in the world, and it is still to be studied from the standpoint of industrial production." — Stanley Cobb.

### RESPIRATORY SYSTEM

Observations and Investigations on the Anaphylactic Bronchial Asthma from Para-Phenylenediamine Dyes. *Curt Gerdon.* Zentralbl. f. Gewerbehyg., Sept., 1920, 8, No. 9, 183. — The author comments on the great incidence of bronchial asthma among workers in furs and pelts since the introduction of para-phenylenediamine as a dye, and on the scarcity of literature on this subject. The first case observed by Curschmann was interpreted not as an acute or even chronic intoxication but as a case of anaphylaxis. The author, in investigating the condition from this standpoint, enters upon a review of Erdmann's discovery that para-phenylenediamine upon weak oxidation is converted into quinone-diimine, which in turn undergoes in aqueous solution trimolecular polymerization. (*Continued.*) — H. V. Williams.

Observations and Investigations on the Anaphylactic Bronchial Asthma from Para-Phenylenediamine Dyes. *Curt Gerdon.* Zentralbl. f. Gewerbehyg., Oct., 1920, 8, No. 10, 188–194. — Para-phenylenediamine is sold under the trade name of ursol D, DD, and P. During one stage of the process there arises a vapor of the dyestuff and it is to this that the

majority of patients attribute their asthmatic attacks.

The author reviews the experiments of Erdmann and Vahlen, in which they found, as evidences of intoxication due to ursol, inflammation of the mucous membrane of the respiratory tract with fatal termination. Moreover the quinone-diimine, the hydrochloride of which was used because of its stability, had a caustic action. Subcutaneous injections in dogs resulted in abscess formation; intravenously there was no effect. In forty cases, von Criegern regarded the effects of phenylenediamine preparations as the expression of a superficial lesion and grouped his cases in three classes.

The author then adds his own views, based on seven cases and the experience of his assistant. Abstracts of the cases are given. No tolerance to this dye takes place, and anyone once sick is sensitized to it. All of Gerdon's cases were of workers who had spent from one-quarter to ten years in contact with ursol before showing the first attack. If after the first attack the patient came in any way in contact with the dye, an attack occurred one-half to twenty-four hours after inhalation of the vapor. The attacks subsided after removal of the ursol, and with furs dyed with other dyes than ursol no symptoms were noted. To these, in his summary of symptoms, the author adds the fact that peculiar odor and taste sensations were apparent to those affected by breathing ursol, which normally is tasteless and odorless.

In order to determine whether para-phenylenediamine and its derivatives can cause anaphylaxis, Gerdon began a series of animal experiments. He employed for intravenous injection a standard solution of quinone-diimine which represented an intermediate product of the dye reaction; a solution of the end-product was administered subcutaneously; and serum from afflicted patients was used for intraperitoneal injection. After standardizing by preliminary tests in which he found no appearances of intoxication as described by Erdmann and Vahlen, three sets of experiments in passive anaphylaxis were undertaken. (*Continued.*) — H. V. Williams.

Observations and Investigations on the Anaphylactic Bronchial Asthma from Para-Phenylenediamine Dyes. *Curt Gerdon.* Zentralbl. f. Gewerbehyg., Nov., 1920, 8, No. 11, 201–208. (*Conclusion.*) — In animals made passively anaphylactic by intraperitoneal injection of Serum V, there is some shock immediately following this injection. If these animals are then given intravenous injections of the standard solution of quinone-diimine the anaphylactic shock occurs. This is found to be milder after an interval of only one or two days than after an interim of three days; in the latter case only is the shock fatal (after twenty-two hours). The symptom picture is made up of a sharp drop in temperature of the guinea-pig, apathy, bristling hair, trembling, chewing movements, free passage of stools and urine, and in the worst cases a rubbing of the fur and labored inspiratory movements. The autopsy showed anasarca, subpleural ecchymoses, lungs emphysematous and the bronchioles constricted.

Similarly sensitized animals were injected subcutaneously after one and two days with a suspension of the dye itself (end product). Mild symptoms of anaphylactic shock were obtained. Therefore, anaphylactic reaction following subcutaneous inoculation is not improbable.

Again, animals sensitized as above were allowed to breathe for six minutes the dye which had been precipitated on fur. In animals which had an interval of two and three days there were mild symptoms, shown by the control to be due to respiratory irritation, followed after one-half hour or more by symptoms of a mild shock, with recovery in four hours. After four or five days, however, these animals died following two hours of severe shock with dyspnea and clonic convulsions. An animal which breathed the dye after an interval of six days had a very severe shock beginning one-half hour later, but recovered completely in seven hours and did not die. The delay in the onset of shock symptoms is thought to be due to the insolubility of the dye in the secretions of the respiratory tract, with delayed absorption. No explanation is made of the apparent recovery and later death in typical anaphylactic shock. The animal which recovered is thought to have had less residual protection from the shock of the sensitizing serum and hence to have had a more severe initial shock, recovery from which was followed by protection long enough to last over the period where the other animals received their fatal shocks.

Active anaphylaxis was produced in sixteen to eighteen days by intravenous injection with the standard solution of quinone-diimine, but it was not produced by subcutaneous inoculation with the suspension of the dye proper.

Of the seventeen guinea-pigs used, several showed an eosinophilia following the second injections (the anaphylaxis provoking doses), most marked on the fourth day afterward, the maximum being 13 per cent. No control animal was so affected. Both controls, which had only the second dose without being sensitized, and the other animals showed increases of mast-cells up to 5 per cent. by the tenth day, appearance of irritation forms of white blood corpuscles and polychromatophilia.

Four of the seventeen guinea-pigs showed respiratory symptoms, but human anaphylactic manifestations are somewhat different. Men may show disturbed contraction of smooth muscle (diarrhea, disturbed micturition and reduced blood pressure) and vasomotor disturbances such as urticaria, gland and joint swellings and edema, besides the recognized spasm of the bronchial muscle and the swelling of bronchial mucosa in asthma. In the seven cases observed, three showed salivation, seven catarrhal colds, three edema, two diarrhea, and two exophthalmos.

It may be that the inspiration of the paraphenylenediamine or its derivatives, which are known to be toxic, by workers in hides and furs, may make the respiratory tract a less resistant place for the localization of the anaphylactic phenomena. There is a high mortality in these occupations where the dye is inspired.

It is concluded that the asthma of furriers is anaphylactic, not toxic. Dr. H. Curschmann, acting on this hypothesis, got at least a transitory improvement in *Case 1* by administering calcium. He advises the prophylactic use of calcium for such workers, since calcium reduces the irritability of the whole nervous system and tends to relax vascular endothelium. — E. L. Sevringhaus.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

A Contribution to the Study of the Toxicology of Tellurium. Il Lavoro, Nov. 30, 1920, 11, No. 7, 204–205. — Before the medical society of Modena at the sitting of June 18, 1920, Luzzati and Levi Angela presented results of researches into the toxicology of tellurium. They show that sodium telluride is one of the most powerful of hemolytic poisons. The microscopic lesions in the organs following poisoning by tellurium compounds are secondary to the intense anemia and the hemoglobinuria, but the organic lesions are not profound. They were not able to demonstrate urobilin or urobilinogen in the urine, showing that the liver functions well. Histologic examination bears this out, for there are few lesions in this organ. They also call attention to the absence of icterus. — Alice Hamilton.

The Early Recognition of Industrial Lead Poisoning with the Aid of Blood Examination. *N. Welwart.* Abstracted as follows from Deutsch. med. Wchnschr., 1920, p. 939 by Globig in Hyg. Rundschau, Aug. 1, 1920, 30, No. 15, 476. — "The statement of Schnitter that 'basophilic stippling' of the red blood cells is almost always the first sign of chronic lead poisoning leads the author to report that in a stool submitted to him to be tested for blood he was unable to demonstrate either blood, iron or bismuth, but that he found lead in large amounts, and antimony in small amounts. He determined subsequently that this lead came from the dust of an ammunition chest at the repair of which the patient — a cabinet maker — was employed, and that this cabinet maker showed no signs of lead poisoning.

"The author considers it possible that in the case of industrial lead poisonings also lead may be demonstrable in the stools, probably earlier than by the above-mentioned change in the blood." — E. L. Sevringhaus.

The Nature of Industrial Lead Poisoning in the Light of Medical Investigation. *Körner.* Abstracted as follows from Zentralbl. f. Gewerbehyg., Sept., 1919, 7, No. 9, 161, in Hyg. Rundschau, July 1, 1920, 30, No. 13, 409. — "A résumé of the symptoms and the onset of lead poisoning; contains nothing new." — E. L. Sevringhaus.

Rare Manifestations of Lead Poisoning. *Rinaldo Cassanello.* Il Lavoro, Oct. 31, 1920, 11, No. 6, 161–165. — Duodenal ulcer is a rare effect of chronic lead poisoning, three cases of which have been seen by the author within little more than a year's time. In all three cases the diagnosis of ulcer of the duodenum

with stenosis was confirmed by surgical operation. Two of the men were painters, exposed to lead for eleven years and for three years, respectively; the third had been a compositor more than ten years. The symptoms of chronic lead poisoning had come on unusually quickly followed by cachexia, and had then yielded to symptoms characteristic of duodenal ulcer with cicatricial stenosis. — Alice Hamilton.

Lead Poisoning in the Glass Industry. Il Lavoro, Oct. 31, 1920, 11, No. 6, 172. — La Sicurezza e l'Igiene nell' Industria, No. 4, 1920, contains the report of cases of lead poisoning discovered in a factory producing lead glass for incandescent lamps. Such glass contains potassium hydrate, soda, and red lead. For the most part, the cases developed in the mixing room where the compounds are handled dry. Eighty such cases have recently been discovered in similar establishments in Vienna, but these were among glass blowers. Examination of the air showed a notable quantity of lead, and lead in vapor form issued from the ovens, but the latter could not be regarded as the exciting cause since the blowers' helpers working near the ovens did not suffer, while the blowers who did suffer were much farther off. The glowing mass of glass worked up by the glass blowers was found to give off vapors rich in lead, and this undoubtedly reached the lungs when the blower inspired air through his pipe. Proof of this was furnished by analysis of the air in a pipe which contained 0.1 gm. of lead. — Alice Hamilton.

Experiences with Industrial Hygiene in the Bavarian Munitions Industry. *F. Koelsch.* Abstracted as follows from Oeffentl. Gsndhtspflg., 1919, p. 257 by Holtzmann in Hyg. Rundschau, July 1, 1920, 30, No. 13, 409–410. — "The author describes the health hazards to which the Bavarian workers engaged in filling shells and the allied operations were exposed. The most poisonous shell contents were those containing dinitrobenzol. This was observed especially in a factory where there were handled consecutively different nitro compounds, binitrotoluol and trinitrotoluol, binitronaphthalene and trinitronaphthalene and dinitrobenzol, and only the latter caused poisoning. The filling of the projectiles was accomplished by pouring in by hand through a funnel and then tamping down firmly. There occurred thus an intimate contact with the material as well as a formation of dust. In general, women are employed in less dangerous work, and are less often taken ill, although their predisposition is greater. The possibility of being affected is increased by unfamiliarity with the work, by high temperatures, by the use of alcohol, and by personal predisposition. According to the author the use of lemonade favors the formation of methemoglobin by raising the alkalinity of the blood.

"Trinitrotoluol, trinitronaphthalene and picric acid appear to be relatively harmless. Factory laborers in general are sick two and one-half times as often as farm laborers of the same region.

"In the preparation of smoke producers for controlling the bursting of projectiles, a mixture of red phosphorus with paraffin and metallic arsenic was employed. From this there occurred irritation of the skin and mucous membranes. General poisoning with arsenic was only observed from accidental ignition of the mass, when an arsenic acid compound was formed. Red phosphorus appeared non-toxic." — E. L. Sevringhaus.

Bladder Tumors in Workers in Chemical Industries. *Schwerin.* Zentralbl. f. Gewerbehyg., April, 1920, 8, No. 4, 64–68. — The author discusses 117 cases of so-called aniline tumors of the bladder in the literature. These tumors have been attributed to the action of aniline, benzidine, naphthylamines, and other amido compounds, but it is impossible to know certainly which compound is responsible without much further study of the exact substances to which the men are exposed and without systematic examination of the urine and use of the cystoscope. The history of these cases shows that there is at first cystitis, sometimes ulceration, then papillomatous growths or polypi, then carcinomatous degeneration. The length of exposure is from six to nineteen years, and cases may develop some years after exposure has ceased. Of ninety-five patients, forty-nine were operated on, thirty-one of them died, eighteen recovered. Prevention consists in doing away with the poisonous substances or shortening the period of exposure. — Alice Hamilton.

The Detection of Aromatic Amido Compounds in the Urine and the Change They Undergo in the Body. *A. Kuchenbecker.* Zentralbl. f. Gewerbehyg., April, 1920, 8, No. 4,

68–71. — As the quantity of amido compounds eliminated in the urine is too small to allow of their isolation, Kuchenbecker attempts to demonstrate their presence by forming azo colors from them. He succeeds in obtaining rose-red azo colors and advises the use of cotton threads which take up no color from the urine, even on boiling, but which take up minute quantities of the azo dye. This test succeeds for the detection of aniline and ortho-toluidine, but not for para-toluidine, benzidine, tolidin, or the naphthylamines. This shows that Leuenberger's statement that bladder tumors are caused by the presence of a hydroxyl-aromatic amido compound in the urine (para-amidophenol, which can be diazotized by Kuchenbecker's procedure) is not true of all cases, for these tumors are found in men working with the substances given above, which do not undergo hydrolysis in the body. — Alice Hamilton.

Occupational Poisoning with Phosgen. *Irene Gerber.* Abstracted as follows from Rev. Med. de la Suisse Romande, June, 1920, 40, No. 6, 356, in Jour. Am. Med. Assn., Aug. 28, 1920, 75, No. 9, 640. — "Gerber's patient was a manufacturing chemist; with two men he was experimenting with phosgen, passing it through alcohol. Each felt some irritation after several hours' work but the two men soon threw off the conjunctivitis and cough. The other after four hours of slight symptoms showed signs of pulmonary asphyxia progressing to a fatal termination the twenty-fourth hour." — M. C. Shorley.

The Action and Intoxication of Inspired Hydrocyanic Acid. *F. Flury* and *W. Heubner.* Abstracted as follows from Biochem. Ztschr., 1919, 95, Nos. 3 and 4, 249–256, by Wesenberg in Hyg. Rundschau, June 15, 1920, 30, No. 12, 379–380. — "The treatment of hydrocyanic acid poisoning with sodium thiosulphate given by Teichmann and Nagel (see the Ztschr., 1920, p. 315) is considered by the authors to be of little promise as indicated by their own animal experiments, since it comes too late. On practical grounds they take a very skeptical attitude also toward the prophylactic method — the injection before work of thiosulphate into those persons engaged in producing the hydrocyanic acid gas. (Compare also the work of H. Fühner on *Hydrocyanic Acid Poisoning and its Treatment*, Deutsch. med. Wchnschr., 1919, p. 847.)" — E. L. Sevringhaus.

Pulmonary Tuberculosis as a Result of Inspiring Tetranitromethane Vapors? *Curschmann.* Abstracted as follows from Zentralbl. f. Gewerbehyg., Oct., 1919, 7, No. 10, 173–175, in Hyg. Rundschau, July 1, 1920, 30, No. 13, 408. — "A worker breathed some fumes of tetranitromethane at work, as a result of which irritative conditions were called forth in his respiratory tract. Pulmonary tuberculosis which appeared was referred to the accident. The possibility of the origin of tuberculosis in this way is admitted by the author; it must be assumed that there is not only an irritation but an ulceration of the mucosa wherein the tubercle bacilli may lodge and develop. If the subject had been completely well and if the breathing of the fumes at one time had caused the anatomic changes in the mucosa, the tuberculous infection could still be looked upon as a sequel to an accident, not only as the end result of an industrial disease. In the above case the initial attack was so slight that damage to the cells of the lungs may be excluded. Between the disaster mentioned, in June, 1919, and the established lung changes in March, 1917, there had been no complaints sufficient to cause a physician to be called. Therefore, the author declines to assert any connection between tuberculosis and the accident in this case." — E. L. Sevringhaus.

Histologic Changes in the Lungs following Inhalation of Bromine. Il Lavoro, Oct. 31, 1920, 11, No. 6, 178. — R. Pellegrini reported to the Medical Society of Rome the results of animal experiments with bromine gas. When death occurred immediately, an intense pulmonary edema was found and severe lesions in the bronchi; if death occurred after several days, a bronchopneumonia was discovered. The author believes that the injury to the alveoli is caused more by prolonged contact with edematous fluid rich in halogen compounds than by the bromine gas because this fluid serves as an excretion path for the bromine absorbed by other organs. Both in acute asphyxia and in the slower form there is fragmentation of the elastic fibers of the lung which is either mechanical or secondary to bronchopneumonia. — Alice Hamilton.

Early Appearance of Secondary Pneumonia after Severe Injuries by Blunt Force and after Poisoning with Illuminating Gas. *G. Strassmann.* Vrtljschr. f.

gerichtl. Med., Jan., 1920, Third Series, 59, No. 1, 82–99. — Pneumonia may occur after severe trauma to the thorax and especially to the head with resulting unconsciousness. Although aspiration pneumonia occurs rather promptly and hypostatic pneumonia only after some intervening time, it is often difficult to determine which type is seen. No distinction is necessary for medico-legal purposes. Also, following poisoning where unconsciousness is caused, as in illuminating gas cases, there may occur either an aspiration of vomitus with immediate death or bronchopneumonia or a hypostatic pneumonia.

This paper concerns the study of forty cases where death followed severe injuries of various types, and of twelve cases where death followed carbon monoxide poisoning. The object was to determine how soon the first signs of pulmonary inflammation appear, and whether a definite time can be set for the first appearance of a secondary pneumonia. Some of these cases had been recorded at autopsy as showing pulmonary inflammation. Sections of the lungs were stained with hematoxylin-eosin and van Gieson stains. Nineteen patients had injuries to the head, including basal fractures, intracranial hemorrhages, and injuries to the brain. Except in two instances all of the forty patients were so severely injured that unconsciousness or stupefaction was produced. (This is apparently the criterion for the selection of the cases from mortuary material.)

In the four patients from the traumatic group, who died practically immediately, there were fat emboli and some edema in three. In the fourteen patients who died within less than a day there was marked edema, hypostatic hyperemia, beginning atelectasis and separation of alveolar epithelium. This may have been "agonal pulmonary edema." Definite pneumonia was not demonstrable. There was evidence of hemoptysis in one out of three patients with cranial injuries, and in two out of six with thoracic injuries. No aspirated gastric contents were identified in any cases.

In the four cases where death occurred after one day there were more definite signs of inflammation. In four patients dying after two days, early pulmonary inflammation was definite, with round cells predominating, red and white blood cells about equal in number, and fibrinous exudate seen at times. In the fourteen remaining patients dying after intervals of from three days to five weeks, some showed more fully developed pneumonia, yet some showed only the very earliest changes, or developed aspiration or hypostatic pneumonia only after some interval of time.

In nine of the cases of poisoning by carbon monoxide the subjects were found dead in rooms filled with the gas. These cases all showed pulmonary edema with a few red and white blood cells in the exudate. Three of the cases also showed alveolar cells containing brown pigment in the exudate, interpreted as due to destruction of red cells in the earlier part of the exudate. The cellular part of the exudate was more marked in one patient dying after thirty-six hours. In a case where death occurred after five days there was pulmonary edema in the posterior parts and some focal pneumonic spots. A patient who died after three weeks showed a well marked but early pneumonia. The pulmonary edema in the cases with rapid death is interpreted as beginning pneumonia. — E. L. Sevringhaus.

## DUST HAZARDS AND THEIR EFFECTS

The Harmfulness of Dust in the Workshop. *H. F. Smyth.* Safety, Aug.-Sept., 1920, 8, Nos. 8, 9, 121–131. — The relation of industrial dusts to diseases of the respiratory system has been studied quite extensively during the last few years. Dr. Smyth gives some of the results of statistical and medical studies of this subject carried out in the United States and abroad. His classification of dusts according to their effects rather than their origin or nature is especially interesting. According to this method of analysis dusts may be grouped as:

1. Cutting — sharp, spiculate, or angular; mineral or metallic dusts as iron, steel, stone, sand, glass, pearl, etc.
2. Irritant — animal or vegetable dusts as wood, ivory, textiles, wool, hair, hemp, etc.
3. Toxic — (*a*) inorganic metallic poisons as lead, arsenic, mercury, etc.; (*b*) organic as picric acid, T.N.T., etc., or volatile organic substances adherent to other dusts as aniline or the iron oxide from an aniline reducer, etc.
4. Soluble — saline dusts which may be irritant or poisonous.

5. Obstructive—dusts such as carbon, rouge flow, etc., which act purely mechanically by their bulk.

6. Infectious — animal or mixed dusts containing disease germs as anthrax from hides or tubercle bacilli from dirty rags, etc., or any dust into which tuberculous persons have expectorated.

The defensive organization of the human respiratory tract against dust and the ways in which dust harms the lungs together with precautions for dusty occupations are also discussed. — G. M. Fair.

Health Hazards of Pottery Workers. *Z. La Forge*. Pub. Health Nurse, Jan., 1920, 12, No. 1, 26–31. — In 1912 an investigation of the pottery industry in the United States was begun by the United States Department of Labor. East Liverpool, Ohio, is the center of this industry in the United States, and the official records of deaths occurring there since 1915 are the chief sources of information for the present study. For further investigation, personal visits were made to one of the large plants and to the workers' homes.

The processes of the manufacture of pottery producing the greatest health risks are the dusty processes of mixing and drying, and the use of lead glaze. In the manipulation of the clay for any purpose, there is some waste or excess which, on drying, becomes dust. Clay dust is as fine as powder, but in reality each fine grain of the powdered clay has a sharp cutting edge. In another process, that of "dipping," by which the glaze is added, the workers are constantly exposed to poisoning by lead, which is one of the chief ingredients of the glaze.

Sanitation of the pottery plants, especially in regard to the reduction and removal of dust, is highly important. The reports of the U. S. Department of Labor show that 85 per cent. of potteries are far from being in a sanitary condition and that, besides the dangers mentioned, exposure to weather and insufficient lighting are common. In addition to the need of improvement, both in the matter of general sanitary conditions and in respect to the special hazards, the housing problem among workers peculiarly exposed by nature of their employment to respiratory diseases is important. In 1913, the mortality from tuberculosis and other respiratory diseases was 37.7 per cent. of deaths from all causes among pottery workers, as compared with 18.2 per cent. among workers engaged in other gainful occupations, as calculated from official reports of deaths in the city of East Liverpool. — G. E. Partridge.

The Action of Dust Inspired in Mines. *Junghans*. (From a communication from J. S. Haldane.) Abstracted as follows from Zentralbl. f. Gewerbehyg., Oct.–Nov., 1919, 7, Nos. 10 and 11, 181 and 200, in Hyg. Rundschau, July 1, 1920, 30, No. 13, 408–409. — "The author reports on observations on pulmonary lesions in coal miners. Coal and clay dust particles appeared relatively harmless and were easily eliminated as compared with quartz. The latter again, as also all other hard minerals, is comparatively harmless when inhaled mixed with clay. The author attributes to coal and clay dust the property of absorbing other substances, as it were, to enter into solid solution with them. Where the respiration of dangerous dust of minerals cannot be reduced, there is recommended a mixture with harmless dust. Coal dust with 60 per cent. clay seems especially suitable since the mixture cannot explode. The author does not say how this is to be done in practice." — E. L. Sevringhaus.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Anthrax in Animal (Horse) Hair: The Modern Industrial and Public Health Menace. *S. Dana Hubbard*. Jour. Am. Med. Assn., Dec. 18, 1920, 75, No. 25, 1687. — During the last seventeen months twenty-four cases of human anthrax, with eleven fatalities, have been reported to the division of industrial hygiene of the New York City Department of Health. These cases have occurred amongst individuals engaged in the handling of hair and it has proved difficult to educate both employers and employees as to the dangers of industry in which unsterilized animal hair is used.

Shaving brushes made of horsehair and a mixture containing horsehair have caused eighteen of the thirty-four cases, with nine

fatalities, and numerous samples of horsehair and shaving brushes made of horsehair have been examined, 80 per cent. of which have shown anthrax spores. Ordinary methods of bleaching, etc., will not kill these spores and as yet it is not known positively whether such disinfectants as mercuric chloride 1:2,500 with 1 per cent. formic acid, or a forty-eight hours' exposure to 2 per cent. hydrochloric acid with 10 per cent. sodium chloride will certainly destroy spores.

The measures to be used in the prevention of anthrax are cleanliness, use of gloves, masks, etc., on the part of workmen, immediate care of skin lesions however small, and sterilization of hair and hides. — C. K. Drinker.

Keeping Workers Well. Factory, Dec. 15, 1920, 25, No. 12, 1908. — That tuberculosis is an occupational disease, is well attested by experts throughout the world. A proper program for preventing this serious disease is herewith outlined under five headings: (1) education of workers and employers; (2) a higher standard of living; (3) improvement of the community environment; (4) correction of faulty personal habits; and (5) provision for institutions to care for the tuberculous. — L. A. Shaw.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Skin Lesions from Coal Tar and Naphtha Derivatives and their Photodynamic Aspects. *F. Koelsch.* Abstracted as follows from Zentralbl. f. Gewerbehyg., Sept., 1919, 7, No. 9, 157, in Hyg. Rundschau, July 1, 1920, 30, No. 13, 406–407. — "From the use of the substitute oils during the war there occurred principally skin lesions, at times so severe as to cause serious reductions in production. Women were especially endangered. Combinations were frequent with the formation of comedones, callosities, acneform growths, and pigmentations. It is characteristic of the coal tar oils that parts of the body exposed to the air are most severely affected and that direct light from the sun or snow makes the malady unendurable. The author also saw severe inflammation from the medicinally used wartime vaseline.

"The coal tar derivatives act in three ways: stopping and irritation of the sebaceous glands, irritation of the skin to overgrowth, and to black coloration, melanosis. This the author refers to a photodynamic action of the coal tar derivatives on the human skin with the exposure to light. This action is especially noticeable with the German coal tar pitch but is lacking with the American product. Also coal tar preparations manufactured during the war, such as 'Karboneol,' exhibit the action. The occasionally noticed dark brown pigmentation of the skin in chlor-acne is related to this, and possibly also the so-called carbol-ochronosus, the grayish black pigmentation of other organs.

"Prophylactically there are to be considered the greatest cleanliness as well as the wearing of suitable working clothes. It is recommended that this most unpleasant irritation by pitch be met by assigning this work to night shifts, or at least by reduction of sunlight. Greasing the hands gives relief. Especially susceptible workers should be removed from the work. Treatment must be combined with cessation from the work. The dermatoses are stubborn, and recurrences frequent." — E. L. Sevringhaus.

Tar-Melanosis in the Making of Dry-Batteries. *Alfred Arnstein.* München. med. Wchnschr., July 30, 1920, 67, No. 31, 902. — Some women in an electric flashlight factory, while spreading thin layers of tar between the elements of the batteries, raised light brown clouds of tar vapor. After a few weeks all their exposed skin took on a deep brown color. It was most intense on the forehead, and faded off rapidly on the neck and elbows. The places of normal pigmentation, such as the nipples and axillae, were not affected. There were no other signs or symptoms, aside from the cosmetic effects, except a moderate eosinophilia.

Arnstein thinks that the cause for this condition is to be found in some impurity in the tar, such as acridine, which sensitizes the skin to light rays and induces a protective pigmentation. He thinks that general malnutrition may be a contributory cause. As prophylaxis he suggests purification of the tar and better ventilation of the factory. — H. G. Noyes.

Impairment of Health from Calcium Cyanamide Fertilizers. *Schlier.* Abstracted as follows from Oeffentl. Gsndhtspflg., 1919, p. 201 by Holtzmann in Hyg. Rundschau,

July 1, 1920, 30, No. 13, 410. — "The author describes a case of periostitis of the hand in a farmer, caused by calcium cyanamide, similar to the periostitis in men who turn mother of pearl." — E. L. Sevringhaus.

Dermatosis Dystrophic-Atrophic of the Lower Limbs from Chilling. Il Lavoro, Oct. 31, 1920, 11, No. 6, 175. — At a meeting of the Medical Society in Milan, Pasini described a case of this form of dermatosis in a man of 50 years of age who, since he was 15 years old, had followed the occupation of salting fish and had been obliged to spend several hours of the day with his feet in icy water. At first there was a transient ischemia of the lower extremities, then permanent congestion with swollen, cyanotic skin, varicose veins, and ulcers, and finally a dystrophic-atrophy of the extremities with perforating ulceration of the soles of the feet. There were no changes in the nervous system which would account for these lesions, sensibility was almost completely preserved. The author attributes the lesions to the prolonged action of cold augmented by standing. The radiograph showed no alteration of the bones. — Alice Hamilton.

Injury of the Cornea by Aniline. *Bachstez.* Abstracted as follows from Wiener Ophth. Ges., Feb. 10, 1919; Zentr. Augenheilk., 1919, Vol. 43, p. 92; Zentr. Biochem. Biophys., Vol. 21, p. 346, by H. S. Paine in Chem. Abstr., Nov. 20, 1920, 14, No. 22, 3465. — "$PhNH_2$ caused sharply defined band-like turbidity and clouding of the epithelium and superficial corneal layers in the region of the palpebral fissure in the case of a cotton-dyer."

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Seventh Annual Meeting of the International Association of Industrial Accident Boards and Commissions. *Carl Hookstadt.* U. S. Bur. Labor Statis., Month. Labor Rev., Nov., 1920, 11, No. 5, 10–19. — A résumé of the above meeting, which included the following topics: accident prevention; eye injuries; systems of rating permanent and partial disability; industrial rehabilitation; systems of compensation insurance; medical problems; miscellaneous subjects; and business section. — R. B. Crain.

Industrial Accident Record of 1919. *Frederick L. Hoffman.* Safety Engin., Nov., 1920, 40, No. 5, 208. — The average rate of fatal accidents in 1919 was 1.08 per 1,000; in 1918, 1.31 per 1,000; in 1915–1919, 1.27 per 1,000. The non-fatal injury rate was 106.5 per 1,000 in 1919; 115.37 per 1,000 in 1918; and 129.65 per 1,000 in 1915–1919. — M. Dent.

Accident Report of 1920. Bull. N. Y. State Indust. Com., Sept., 1920, 5, No. 12, 221. — The Bureau of Compensation of the State Industrial Commission reports that in the year ended June 30, 1920, there were 345,672 industrial accidents reported to the New York State Industrial Commission. Of these, there were filed with the Commission 52,251 claims for compensation, indicating that many persons were disabled beyond two weeks, as compensation is not paid the first two weeks. There were 12,832 direct settlements of compensation claims between employers and employees. There were 1,275 fatal accidents resulting in death claims. Of the total number of accidents 232,303 were reported in the New York City district and 29,957 of the compensable accidents were there. — K. R. Drinker.

Eastman Kodak Company Cuts Accident Severity and Frequency Rates. Nat. Safety News, Aug. 30, 1920, 2, No. 9, 7. — A reduction of 47 per cent. in accident severity rate and of 30 per cent. in the accident frequency rate for the first six months of 1920, as compared with the corresponding period of 1919, is reported by the Eastman Kodak Company.

A reduction of approximately 50 per cent. in the number of lost-time accidents and a saving of 388 days in lost time due to accidents also are noted in the report covering accidents at the Camera Works of this company, from January 2 to June 1, 1920. A table is given. — M. Dent.

What the Ohio State Industrial Commission Has Done to Promote Safety Education. *F. G. Lange.* Nat. Safety News, Nov. 8, 1920, 2, No. 19, 5. — The problem of safety education includes not only about 1,000 deaths annually reported to the Ohio Industrial Commission but 6,500 accidental deaths not reported, as outside industry. Training for safety

from childhood is thought possible but it is a difficult task with adults who require constant repetition to instill new mental habits; hence Lange proposed before the Industrial Commission a school safety propaganda. A letter was sent to every city, county and district superintendent in the state. The co-operation of all newspapers, presidents of local Federations of Women's Clubs, and the state president of the Ohio Federation of Women was secured. The letter sent to all school principals advised as follows:

1. That safety education shall henceforth be a part of the curriculum.

2. That the plan to effect this shall be as follows: (*a*) A Central School Safety Council shall be organized, charged with the development of school safety; (*b*) Each school shall have one teacher representative on the council, who shall receive full professional credit for work done along this line; (*c*) There shall be a council president, vice-president, and secretary, elected by the representatives; (*d*) Such committees as are deemed necessary shall be created. There may be a committee on methods of teaching safety, a statistical committee, etc.; (*e*) The council shall meet every week (two or four weeks) at . . . place, to discuss any accidents which may have occurred since last meeting; to formulate ways and means of preventing future accidents; to discuss present methods of teaching safety and possible improvements.

3. That the person chosen as representative shall have charge of the safety program in the school which he represents, and shall (*a*) inspect the conditions in and surrounding the school and the district traversed by the children on their way to school, in order to discover dangerous conditions and secure their correction; (*b*) organize a school safety council, each class electing one or more pupil representatives thereto. The school safety council shall be charged with the safety of the pupils; (*c*) receive from the class representatives reports on accidents occurring to the pupils. These reports shall be investigated when necessary. All reports shall be tabulated and then transmitted to the Central Safety Council. — F. Fremont-Smith.

Safety Organization. *A. P. Costigane.* Safety, Aug.–Sept., 1920, 8, No. 8–9, 134–144. — This paper discusses the organization of industrial plants for the purpose of preventing accidents and gives details of results obtained by the Ontario Pulp and Paper Makers' Safety Association. The plan of the Association to prepare a set of text-books on the subject of "Safety" is of especial interest. — G. M. Fair.

Defective Illumination, a Cause of Industrial Accidents. *R. E. Simpson.* Safety Engin., Nov., 1920, 40, No. 5, 204–207. — About 15 per cent. of industrial accidents are caused by defective lighting. These accidents cost industry $300,000,000 every year, a sum more than the cost of the lighting. Ninety per cent. of employees have defects in vision, and in the majority of cases these could be remedied by glasses. Poor eyesight causes ill health, carelessness, dullness, and listlessness generally.

The author stresses the need for reflectors, sufficient light, and lighting in stairways, passages, and storerooms, where danger points cannot be seen. — M. Dent.

Radium in the Safety Movement. Safety Engin., Nov., 1920, 40, No. 5, 210. — Radium may be used as: (1) a therapeutic agent, treating thousands of cases of cancer yearly; (2) in industry. Many accidents in factories and mines can be eliminated by the use of luminous radium material on high pressure gauges, electric switches, fire alarms and extinguishers, telephones, bells, etc., all of which should be lighted night and day. Dark bolts, channels in mines, etc., touched with radium will glow dependably without danger of explosion or burning when other lights fail, fuses blow out and wires break down. — M. Dent.

Reduction of Accidents through Visual Acuity. *H. F. J. Porter.* Safety Engin., Nov., 1920, 40, No. 5, 195–200. — Visual acuity is the possession of efficient vision. Very few people have perfect eyes. Employers should realize their responsibility and insist on eye correction and proper illumination.

1. Bright lights paralyze the muscles of the eye; they should be shielded and glare prevented.

2. Flickering lights tire the muscles of the eye and cause headaches.

3. General illumination should be made as even as possible, without shadows. Work planes should have from 10 to 15 foot-candles illumination.

Fifteen thousand deaths per year are caused from falls; most falls are caused by poor vision and faulty illumination. — M. Dent.

Goggles Save Eyes Every Day. Safety Engin., Sept., 1920, 40, No. 3, 103. — A description of an accident to a workman from an explosion of aluminum spilled onto the floor, and how his goggles saved his eyes, though his face was badly burned. — M. Dent.

Tanks and Pipe Lines as Causes of Accidents. *Homer A. Hoffman.* Chem. and Metall. Engin., Nov. 21, 1920, 23, No. 21, 1023–1025. — A study of hazards involved in the use of storage tanks and pipe line distributing systems in chemical plants together with instructions for the safe construction, cleaning and repairing of underground and overhead tanks and pipe lines. — G. M. Fair.

The Progress of Safety Work in the Shipbuilding Industry. *T. A. Walsh.* Safety, Oct., 1920, 8, No. 10, 159–166. — This address given before the Ninth Annual Congress gives a description of the advances made in removing or reducing the prominent causes of injury in the shipbuilding industry. — G. M. Fair.

Safeguarding Woodworking Machinery. *F. G. Lovett.* Safety Engin., Oct., 1920, 40, No. 4, 177–178. — Woodworking tools are perhaps the most hazardous of all classes of machines, and of these the saw is the cause of most accidents. The need is stressed of providing adequate safeguards — the practical sort which the employee will not throw into the scrap pile; of improving lighting systems; and of improving the general condition of most of our mills, especially planing mills, which, the author asserts, are as they were forty years ago. — M. Dent.

Rules and Regulations for Safeguarding Woodworking Machinery. Mass. Dept. Labor and Industries, Indust. Bull. No. 16, 1920, pp. 10. — This bulletin contains specific rules of the Safety Department, and recommendations of the Commission for safeguarding woodworking machinery. — M. Dent.

A Practical Guard for Contact Points of Sheave-Wheels and Cables. *T. W. Osgood.* Safety Engin., Nov., 1920, 40, No. 5, 209–210. — An unreasonable number of accidents to fingers, hands, and arms are due to catching these members between cables and sheave-wheels at points where the former run into the latter. A diagrammatic picture and detailed description of a guard are given. — M. Dent.

Makes Toggle Presses Safe. Safety Engin., Oct., 1920, 40, No. 4, 179–180. — "A Cleveland rubber company is using magnetic clutches, operated by limit switches of the rotating cam type, with their toggle presses to eliminate any possibility of the operators being caught between the platen and upper head of the press when reaching in to remove the finished product or to insert the molding material." — M. Dent.

Can the Producers of and Contractors for Machines Be Made Legally Responsible in General for the Provision of Safety Appliances? *Hirsing.* Abstracted as follows from Zentralbl. f. Gewerbehyg., Oct., 1919, 7, No. 10, 175, in Hyg. Rundschau, July 1, 1920, 30, No. 13, 409. — "The question is discussed by a worker. Heretofore the regulations have failed because of the difficulty in deciding in the case of each machine which is the best conceivable safety device and therefore the one to be required. The author recommends a commission of workers and experts which after practical experience should propose to the central office for accident prevention the best safety device for each machine. This office must be in closest relation with the governmental industrial inspection officials, who should in the future be alone responsible for the preparation of directions for accident prevention and for supervising their carrying out." — E. L. Sevringhaus.

A Fatal Accident in a Low Voltage Installation. *C. Heydrich.* Zentralbl. f. Gewerbehyg., Dec., 1920, 8, No. 12, 239–240. — A workman in a peat field struck an electric cable with his neck, grasped it with his hand and stood motionless until the current was turned off. He fell dead and could not be resuscitated. The cable carried a 220 volt supply to a motor in the field. The accident was due to a faulty type of cable and faulty installation. The cable contained too inflexible a stranded copper wire, which by bending was broken and then pushed through the insulation to come into contact with the metal armor of the cable. The metal armor was not grounded, nor was the cable weather proof. The danger of 220 volt installations is not generally appreciated. — E. L. Sevringhaus.

Safety Disconnecting Hangers as a Safeguard. *A. J. Thompson.* Safety Engin., Nov., 1920, 40, No. 5, 202–204. — The cleaning and repairing of electric lamps is necessary for safety and production, but travelling cranes and ladders are extremely unsafe for such purposes. Cleansing and repairing are facilitated by having lamps on safety disconnecting hangers. No climbing is necessary. The lamp comes down without any dangling loops of wire, and the lowering automatically disconnects it from the electric current, makes it safe to handle, and eliminates climbing hazards. — M. Dent.

## INDUSTRIAL SURGERY

Industrial Surgery as a Specialty. *William O'Neill Sherman.* Mod. Med., Jan., 1921, 3, No. 1, 29–30. — This specialty is demanded by the growing sense of responsibility of progressive and humane employers as well as by the enactment of employer's liability legislation.

Originally the plan for securing medical attention was contract practice which often resulted in the directing doctor getting the lion's share of the collections. In isolated communities where this still obtains and where it is necessary to collect a fixed sum from the employees, an attempt should be made along the lines of a group system, somewhat comparable to the Mayo Clinic.

Industrial surgery has been greatly modified by the experience gained in war surgery. There are many more resources at our disposal for the saving of lives and limbs today than there were six years ago. These resources should be adopted without further delay. Infection should be a thing of the past. All methods to shorten disability and all methods to lessen permanent disability should be studied and practiced, both by individuals and in the medical schools of the country. A post-graduate course in some large industrial center is to be hoped for. More conferences with state departments of industry, etc., are needed, since those already held have proved of constructive value. — Elinor D. Gregg.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Tests for Physical Fitness. *C. B. Heald* and *B. Thomson.* Abstracted as follows from the Lancet, Oct. 9, 1920, 2, No. 15, 736–741 in Physiol. Abstr., Dec., 1920, 5, No. 9, 400. — "Two methods specially were selected — viz., Dreyer's of vital capacity, and Flack's breath-holding tests. The authors believe them capable of great extension, and hope to obtain from them useful 'efficiency factors.' So far as one can gather from the paper the methods are almost incapable of 'formulative expression.' (Whether this mathematical deficiency is a genuine evil it is difficult to judge, for the paper is written in highly technical mathematical language. The authors would be doing biological and medical readers a service if they could explain their meaning in plain English.)" — McKeen Cattell.

Biochemical Studies on Marine Organisms. II. The Occurrence of Zinc. *M. Bodansky.* Jour. Biol. Chem., Nov., 1920, 44, No. 2, 399–407. — A brief review of the literature on the physiological occurrence of zinc is given. Determinators of the zinc content of the tissues of twenty species of marine animals were made by Birckner's turbidimetric method. (See Birckner: Jour. Biol. Chem., 1919, Vol. 38, 191.) Zinc was found and quantitated in every species studied and the author concludes that it is a normal constituent of the tissues. — A. S. Minot.

Acetonuria of Fatigue during Alimentation. *Azzi Azzo.* Abstracted as follows from Riforma Medica, 1919, in Il Lavoro, Nov. 30, 1920, 11, No. 7, 202. — Azzo confirms the assertion made by Preti in 1910 that muscular labor causes acetonuria. The author carried out his tests on an adult healthy man who was on a constant mixed diet. He gave particular attention to the elimination of ketones and observed that during fatigue the phenomenon of acetonuria appeared and remained above normal as long as the subject took no food, nor did it subside quickly on cessation of exercise. Acetonuria reappeared if, after taking food, the subject underwent exercise more fatiguing than

usual, but in this case it did not persist and it disappeared quickly with repose. It is difficult to say if the phenomenon depends on an increase of organic combustion and therefore the passage into the circulation of a larger quantity than normal of the ordinary products of metabolism, or if it depends on a transient alteration of metabolism through an excessive, abnormal destruction of the reserve fats and hydrocarbons. The presence in the blood of large quantities of acetone bodies, however, constitutes a state of intoxication which has an effect on the nervous system especially, and it cannot be denied that, together with other poisons formed during work, it is one of the causes of the sensation of exhaustion. — Alice Hamilton.

Effect of Shorter Hours of Work on Output and Health. From Foreign Letters, Jour. Am. Med. Assn., Nov. 27, 1920, 75, No. 22, 1509. — "The annual report of the chief inspector of factories and workshops for 1919 shows that the shortening of hours, perhaps more than any other recent improvement in industrial conditions, has had a beneficial effect on operatives. Better time-keeping has been the result of discontinuing work before breakfast. There is also less absence for sickness and other reasons. In one large factory the average daily number of absentees numbered forty some years ago; now, with a forty-four hour week, the average number has dropped to ten. Less fatigue and overstrain are found in factories, and although more men are employed in the engineering and allied trades, the accident list has not increased. Increased leisure has been used by many workers for educational advantage. The reports of various inspectors disclose wide differences as to the effect of shorter hours on production. When the production depends almost entirely on the speed of machinery, as in cotton and woolen spinning, the output is reduced in a proportion nearly corresponding to the reduction of hours. In other machine operations which call for constant alertness, such as weaving, output has not suffered to this extent, and in exceptional cases has been scarcely affected. In a third class of processes, in which output is largely or entirely dependent on the exertion of the worker, there is frequently no loss in production. Indeed, in one wholesale tailoring establishment an increase of 40 per cent. was reported; but this was partly due to reorganization. In a boot factory in which the hours were reduced from fifty-two to forty-eight a week there was a considerable increase in output. Unfortunately, a few of the reports indicate an exceedingly unfavorable result in some work where the shortening of hours has been followed by a reduction in the hourly rate of production; and for this, no adequate explanation, as a rule, is given." — C. K. Drinker.

One Day of Rest in Seven for District of Columbia Workers. *Editorial.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 256–257. — A bill for one day of rest in seven, which conforms with a standard bill prepared by the American Association for Labor Legislation and recognizes that while we can and must have continuous industries we cannot and must not try to have continuous men and women, has been introduced for passage at the session of Congress beginning in December. The standard bill covers the following points:

1. *Scope of Act.* — Every employer in a factory or mercantile establishment shall allow every employee except those specified under (2) at least twenty-four consecutive hours of rest in every seven consecutive days. No employer shall operate a factory or mercantile establishment on Sunday except as provided under (3).

2. *Exceptions.* — Janitors; watchmen; employees whose duties include not more than three hours' work on Sunday at specified tasks; superintendents or foremen in charge; employees in the production of certain foods, where not more than seven persons are employed.

3. *Schedule for Sunday Workers.* — A list of employees who are to work on Sundays, designating the day of rest for each, is to be posted conspicuously and a copy filed with (the Commissioner of Labor).

4. *Time Book.* — A book showing names of employees and their hours must be always open to inspection by the commissioner of labor.

5. *Penalty.* — A fine of $5.00 will be collected for each offense. — Elizabeth C. Putnam.

Three Shifts in Steel. *A. Adele Shaw.* Survey, Dec. 11, 1920, 45, No. 11, 387–388. — At a joint meeting of the Taylor Society, the Management and Metropolitan Sections of the American Society of Mechanical Engineers, and the New York Section of the American Institute of Electrical Engineers, convoked to

discuss the Long Day in the Steel Industry, the assembly agreed that whether or not they approved the three-shift system, the time had come for a change and the real question was how it should be brought about. While some agree that the change should be to an eight-hour day, others felt that, except as a matter of convenient division of hours in a process that must be continuous, a ten-hour day could be managed. Mr. Drury, formerly of the Economic Department of Ohio State University and recently with the Industrial Relations Division of the United States Shipping Board, summarized his findings in a detailed study of five three-shift plants, as follows:

1. *Effect on Managers.* — "Practically all of them are glad they made the change."

Manufacturers kept saying that they "regarded the three-shift better from a business standpoint."

"Probably the real reason why nearly all the three-shift manufacturers with whom I spoke were in favor of continuing was because of those not easily measured efficiencies that spring out of the spirit of the men."

Reported a marked improvement in absenteeism.

2. *Effect on Workers.* — "After the men have once got used to the three-shift system, you could not pull it away from them with tongs."

3. *Increase in Men Needed.* — Thirty-five per cent. increase conservative. From 50 per cent. in some mills to 11 per cent. in American Rolling Mills.

4. *Increase in Wage Rates.* — Twenty-five per cent. maximum that would be required, even under conditions of shortage of labor.

"It has been shown that the men see the reasonableness of paying for their greater leisure by some reduction in total earnings."

5. *Increase in Output.* — Average 10 per cent.

The cost of making the change, Mr. Drury further pointed out, is entirely incommensurate with its importance. "If there were no increased efficiency at all; if the plant increased its force of shift men full 50 per cent.; if the output were no greater than under two shifts, and the hourly wage rates raised 25 per cent., the total additional cost for the steel ingot would not be more than 46 per cent., while it sells for about that many dollars." According to a statement by W. H. Baldwin, former Secretary of the Ohio Steel Company, not only did the government investigations of ten years ago show that the profits from steel were so great that the industry could have then stood the three shifts, but nothing could "contribute so much to better feeling between employer and employee and keep out outside influences." — Elizabeth C. Putnam.

## WOMEN AND CHILDREN IN INDUSTRY

The New Position of Women in American Industry. U. S. Dept. Labor, Women's Bur., Bull. No. 12, 1920, pp. 158. — A report is here given of the industrial opportunities which the war brought to women, and of the present status of women in labor. The work of men and women in the same types of work is compared, industry by industry. — M. Dent.

Telephone Industry Investigation. Bull. N. Y. State Indust. Com., March, 1920, 5, No. 6, 113; April, 1920, 5, No. 7, 137; May, 1920, 5, No. 8, 157; June, 1920, 5, No. 9, 174, 179; July, 1920, 5, No. 10, 189–190, 197. — This is a report of a recent investigation of the telephone industry by the Bureau of Women in Industry. Health is required for the necessary concentration of mind and alertness of hand of the operator. The company recognizes this and arranges for adequate light, heat, ventilation and comfort, especially in the larger cities. Ventilation is the chief physical difficulty of the operating room. In the larger cities forced drafts are installed, but in smaller ones windows and fans are relied upon. The rooms are in hourly use the year round, hence the difficulty of thorough airing daily. Adjustable chairs reduce fatigue to the minimum. In most operating exchanges, washing facilities and toilets are ample and clean, as are also the lockers. Rest rooms are adequate for the relief periods, a victrola and piano being provided and an attempt made at having very attractive rooms. One employee devotes her entire time to planning and inspecting the rest rooms in the Manhattan and Bronx Division. A reasonable amount of current literature and periodicals is provided. The New York Telephone Company has gone further than the majority of large employers of women in paying particular

attention to the physical conditions under which its employees work.

*Lunch Room Service.* — For a number of years the company has furnished free tea, coffee, sugar, and condensed milk to the girls; now cafeterias are being installed with food at or below cost and continued free tea, coffee, etc. Of thirty buildings containing exchanges, twenty-six have regular cafeteria service. Outside Manhattan and the Bronx, however, cafeteria service is as yet not largely developed.

The cost of training an operator is from \$68 to \$100. For every three operators entering the service, one drops out in training, and a second, before the end of the first year. The third stays longer. According to the company's statistics, only after two years' service is an operator competent to carry efficiently the theoretic load of 230 calls per hour. In Manhattan $24\frac{1}{3}$ per cent. had been with the company, after training, six months or less; 13.7 per cent., from six months to one year; 13.4 per cent., over one year and through two years. The problem of the telephone company is in retaining operators beyond the two year period, when their maximum efficiency is being reached.

*Medical Department.* — There is need of special study of fatigue in the whole telephone system. The New York Bell Telephone Company employs twenty-seven physicians three hours daily, and fifteen graduate nurses full time. The New York medical department is fully equipped for blood tests, X-ray, and other laboratory work. A medical examination, given by women doctors, is requisite to entering the service. In 1919, from 9,429 applicants, 8.6 per cent. were rejected for physical disability; 20 per cent. of these rejections were for lung conditions, 10 per cent. for nervous disorders, and 18 per cent. because of underdevelopment. There is no doubt but that the number of losses from the operating force could be considerably reduced if the telephone company undertook a more thorough medical supervision of the operators, and applied the results to making the operator fit her job. The whole trend of telephonic invention has been to intensify the strain by heightening the speed, with little attention to the effect upon the operator or her children. The problem from this point of view is medical, and by study, a valuable contribution could be made to this subject.

Basic time is forty-eight hours a week for the day time and forty-two hours for evenings and split work, but actual working hours differ on account of the shifts. Sometimes it is necessary to work overtime and sometimes undertime. Twenty-five per cent. of the operators in New York State work over time with increased pay, which is poor policy from the physical standpoint. In the week ending December 13, 1919, 2.3 per cent. of the New York force worked seven days; 91 per cent. more than six days. The company is making every effort to reduce overtime work, which results in absence and undue nervous strain. Absence, often unavoidable, may also be due to fatigue, over-long hours, or insufficient wage incentive. Statistics of a sample day with normal weather and no epidemic show that 8.79 per cent. of the total force in New York State was absent. Broken time, which means time less than one day and more than one hour of expected duty, as well as absenteeism reduces the efficiency of the service to the public.

Including overtime wages in Manhattan Division, where 538 operators received \$18 to \$19 per week, the regular minimum wage being \$15, 336 operators received under \$12, 2,485 between \$18 and \$21, and 1,976 between \$21 and \$25. Wages were increased in 1919, but the Bureau of Women in Industry believes that the maximum rate could be advantageously increased and promotions made more rapidly, to increase the permanency of the organized force. The Bureau recommends (1) an amendment to the labor law subjecting exchanges to the same supervision of the industrial Commission as the factory and mercantile establishments, and (2) consideration by the Public Health Service Commission of such parts of the above report as bear upon inadequacy of telephone service. — F. Fremont-Smith.

THE PSYCHOLOGICAL APPROACH TO THE CHILD LABOR PROBLEM. *R. G. Fuller.* Am. Child, Aug., 1920, 2, No. 2, 119–127. — The data of modern psychology are increasingly valuable for the understanding and interpretation of the child labor evil, and in the actual procedure of child labor reform psychology will be of great practical value. The evil of child labor is not to be measured wholly in terms of what child labor does to some children; it must be estimated also with reference to what society ought to do for all children. There are several important distinctions, made possible by modern psychology, which must be regarded: such as that between child labor, which is a social

evil, and child work, which is a biological good; or, again, the distinction between the needs of the child as regards his preparation for adult life and his requirements as a child. The central and dominant interest should be in the child as a child. He is the proper point of departure in child labor reform. We must ask first what constitutes a normal childhood. Psychology would answer that activity in which old racial experience is re-enacted in childhood is developmental and hygienic. It coincides with a normal motor life, which is more than physical activity, being also psychical. Activity in childhood, psychology shows also, becomes increasingly constructive. Both educational activities and work must conform to these normal laws and qualities of childhood. In considering what is normal in work for the child, we must take motivation into consideration: such as filial devotion, the self-assertive instinct in its various forms of expression, the desire for independence, the desire for money for the sake of possessing it or for its use in self-display or in indulgence and amusement, the desire to imitate friends, the spirit of adventure, etc.

Applied psychology must give attention to the causes and consequences of change of employment; it must consider the problems of mental hygiene connected with child work — such problems as that created by work done with defective psychic impulsion, which produces friction and thus fatigue. The effects of such work would be studied in their contrasts to the physical, mental, and moral benefits of a normal play life. Children possess work impulses as well as play impulses, but both are repressed by child labor. Any occupation that causes over-use of the accessory small muscles or continually restricts the use of the large fundamental muscles; any occupation that precludes the development of the finer neuro-muscular co-ordinations, such as much of ordinary farm work; any occupation that tends toward the formation of bad motor habits; any sedentary occupation; any occupation that stands in the way of a wholesome objective life; any occupation that interferes with a full childhood is far from being a gainful occupation. — G. E. Partridge.

The Juvenile Court and Child Labor. *Mabel B. Ellis.* Am. Child, Aug., 1920, 2, No. 2, 128–138. — The juvenile court occupies a good vantage ground from which to view the operation of child labor laws and to aid in their enforcement; it is not strange, therefore, that in at least six states probation officers are specifically mentioned among those charged with the enforcement of the child labor law, and that in at least twenty-five states peace officers and truant officers, who often are the only probation officers for small courts, are so named. No juvenile court, which rightly interprets its function of searching out and seeking to remove the causes of juvenile maladjustment, will fail to note the frequency with which premature or unsuitable employment enters as a factor. The officer of the juvenile court must take a broader view than the mere legal one. He must study the mental and physical condition of the child. Knowledge concerning the employment of the child is highly important, and the effects of the occupation upon the child during the period of probation — the president of the National Probation Association has urged that this period be usually not less than a year — must be watched closely.

Another problem in which the juvenile court is concerned is that of work in institutions. The question of child labor in institutions must be faced squarely. It is difficult to draw the line between work which is educational and work which is mere drudgery, but we shall have no training schools in a real sense, until household managers and farm foremen in these institutions have professional training for their work and assume a professional attitude toward it. — G. E. Partridge.

Health and the Working Child. *H. H. Mitchell.* Pub. Health Nurse, Jan., 1920, 12, No. 1, 31–33. — The health of the working child stands between two great public health specialties — school hygiene and industrial hygiene. The working child represents probably one-fifth of our population between the ages of 14 and 15 years, and is particularly in need of health supervision. Thus far only sixteen of the states require a certificate of physical fitness from a physician before a child is allowed to engage in wage-earning pursuits. In a few cities, the child is required to return for examination whenever he changes his employment. Examining physicians are, however, often lenient, and the restrictions do not reach a large number of children with the milder physical defects. If we recognize that our only excuse for *any* child labor is real economic hardship, it should be clear that it is not econ-

omy to allow a child with physical defects to risk his health in occupations involving severe strain, excessive fatigue or exposure to poisonous substances or dust. The medical examination that rejects 3 or even 10 per cent. of the applicants and then gives them no further attention is not sufficiently protecting the health of children.

There is serious need for some further supervision of the health of working children. It is not sufficient merely to examine the child. If he has any physical defects, even in a mild degree, they may prove enough to break down his physical resistance. Periodic physical examinations are essential, and with the development of the continuation school there should be given to the working child such health supervision that when he reaches maturity he may enter the industrial world with a body at least free from disease or physical weakness. — G. E. Partridge.

What Is Health Protection for Working Children? *H. H. Mitchell.* Am. Child, Aug., 1920, 2, No. 2, 145–150. — The value of physical fitness certificates of children applying for permits to work has probably been very much overestimated. The value of physical examinations under the present methods of administration is, in fact, very limited, and it is certain that a much smaller number are refused work permits, or are held until corrections are obtained, than appear to be the total number of defective children among those examined. Cities in which 20 to 30 per cent. of the children are refused on first examination and 5 per cent. finally refused are probably considerably above the average in the physical standards required for a certificate. What is needed is a more flexible system, discretionary power in the administration of the laws, a scientific point of view, and means of following up and treating cases individually. Each certificate might be issued for a particular occupation. The physician should not be placed in the impossible position of having, as his only means of protecting a child's health, the refusal of a permit. In the larger cities there should be full-time medical executives giving especial study to the health problems of the working child, and in the smaller cities the needs may be met by grouping several welfare activities so that trained social workers will be employed who will direct the issuance of work permits and follow the advice of part-time medical examiners in protecting the health of each individual child. — G. E. Partridge.

Examination of Children for Industries. Medical Notes. Boston Med. and Surg. Jour., Oct. 21, 1920, 183, No. 17, 500. — The Massachusetts Department of Labor and Industries calls attention to the provision of the school attendance law in regard to the issuance of working certificates to children between the ages of 14 and 16. The child must be examined by a physician and found physically able to perform the work which he intends to do. The object of the law is defeated unless the examination of the child is definitely related to the work upon which he desires to enter. It has been revealed that certificates have been issued after a superficial examination or even when no examination has been made. — Barnett Cohen.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Industrial Sanitation. *W. N. Fitch.* Safety Engin., Oct., 1920, 40, No. 4, 163–168. — Workmen are affected in their health, habits, personal appearance and efficiency by the environment under which they work. This paper discusses the following important items of good industrial sanitation, applicable not only to new, but to old constructions:

1. *General Cleanliness.* — No type of sanitation is more neglected. There should be sufficient light, and pure air — clear of dust or poisonous vapors. The broom and brush should be relegated to the dump heap, and vacuum cleaners installed.

2. *Drinking Water.* — Water for drinking purposes should be clear, pure, and of an agreeable temperature. Methods of purifying and cooling are discussed, and for further information readers are referred to United States Public Health Bulletin, May 11, 1917, Volume 32.

3. *Cuspidors.* — A fairly sanitary cuspidor is described.

4. *Toilets.* — Toilets are very much neglected in some industries. They should always

be inside the factory. Eleven practical points of good sanitary toilets are given.

5. *Necessities and Comforts.* — Under this head lockers, baths, and lunchrooms are discussed. — M. Dent.

Elements of Good Industrial Lighting. *S. E. Doane.* Safety Engin., Nov., 1920, 40, No. 5, 201–202. — Putting aside such elements of good lighting as lack of glare, uniformity of light distribution, etc., the author stresses speed of vision. "Laboratory tests have been designed and study is progressing to put values in fractions of a second to the speed of vision under various conditions of quantity and quality of light; in amount of contrast between background, etc." When the light is dim we make a longer exposure on the photographic plate. It is the same with the camera as with the human eye. "There is ample evidence to show that the brain receives no notice whatsoever that the picture is being recorded on the retina of the eye until the time such exposure reaches some definite value which is a function of the light intensity. The time that the eye takes under practically all conditions of artificial lighting is measurable in considerable fractions of a second." Hence, the poorer the lighting the slower the workman. — M. Dent.

Industrial Lighting in Relation to Health and Safety. *L. Gaster.* Jour. State Med., Sept., 1920, 28, No. 9, 274–282. — When the outbreak of the war occurred, there was a movement already begun in several of the most important countries to obtain a fuller knowledge of lighting in factories. The work was interrupted in some of the countries, but in England a report was printed in 1915, based on a series of over 4000 measurements of illumination in 163 workrooms in factories throughout the country. The report recommended statutory provisions demanding certain conditions to be fulfilled in industrial lighting, but this recommendation was not carried out because of conditions brought on by the war. Progress has been made also in the introduction of simple apparatus for measuring illumination, there now being a variety of types available.

Six states in the United States now possess codes of industrial lighting, following lines adopted in the British Departmental Committee's report, but containing more detailed prescriptions, specifying generally the amount of illumination in foot-candles for rough, fine and very fine work.

A survey of industrial lighting has recently been published by R. P. Eastman in the Transactions of the American Illuminating Engineering Society, summarizing the results of visits to 446 institutions in fifteen states. About 80 per cent. of the men interviewed agreed that better lighting leads to an increase in production. Many thought it brought about a decrease in spoilage; that it was useful in preventing accidents; that it led to improvement in discipline; that it led to better hygienic conditions.

Statistics in regard to accident rate presented in the report of the British Home Office Department Committee on Lighting in Factories and Workshops show the relative frequency of accidents in night and day work. It was found that almost invariably the accident rate was higher in night work, the average increase being 29 per cent. for all forms of accident, and 74 per cent. in the case of persons falling. The Commonwealth Edison Company of Chicago recently made an investigation of the lighting conditions in ninety-three factories. It was arranged to light these factories for several months, first with the ordinary illuminations and then with higher illumination, an account of output being kept. In one case the improved illumination resulted in an increased output varying from 8 per cent. to 27 per cent. in different departments, and it was concluded that, on the average, an increased cost of lighting amounting to not more than 5 per cent. of the payroll would lead to an increased production of 15 per cent.

The writer emphasizes the value of international agreement on regulations in regard to factory lighting. — G. E. Partridge.

Selling Better Lighting as an Aid to Safety, Conservation of Vision and Increased Production. *John A. Hoeveler.* Safety, Nov.–Dec., 1920, 8, No. 11–12, 193–200. — This paper, in the form of a dialogue between an inspector of the Industrial Commission of Wisconsin and the owner of a factory where the artificial lighting was far below code standard, brings out the salient reasons why better lighting is of advantage to industrial plants. The reasons themselves are too well known to be repeated. — G. M. Fair.

What One Plant Has Learned about Lighting. *James J. McLaughlin.* Factory, Nov. 1, 1920, 25, No. 9, 1413–1415. — Among the factors of good lighting are reduction of ac-

cidents, increased accuracy in workmanship, reduction of spoiled material, and a general increase in production. The worker experiences less eye-strain and is freed from the fatigue which accompanies it. Good lighting also makes for better supervision and generally higher standards in a department. Of 91,000 accidents recorded by an insurance company within a year 23.8 per cent. were attributed to improper or inadequate lighting. In many instances the impairment of vision due to poor lighting does not become evident for a considerable time. While this obviously reacts unsatisfactorily in the case of the workman, it is just as definite a calamity to the state in that it shortens the productive career of the individual.

The greater part of this article is devoted to a discussion of the relative merits of local and general lighting systems. Some of the undesirable features of local lighting are direction of light to the eye rather than to the work where reflectors are not used, irregular distribution of light in a room, making dark corners, rapid deterioration of reflectors where they can be handled by workmen, and eye-strain due to wide variability in light intensity.

Several illustrations are given to call attention to these difficulties. In a few jobs it is impossible to use general lighting effectively. This is true where it is necessary to illuminate the inside of material in process of manufacture, such as cylinder boring. Here a portable light on a standard can be used effectively. In conclusion the writer calls attention to a table which he gives based on state lighting codes and showing intensities for various occupations and industries. — C. H. Paull.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Industry Needs an Adequate Medical Service. *Hugh S. Cumming.* Nat. Safety News, Sept. 6, 1920, 2, No. 10, 7. — The author gives in very concise form the chief reasons for the establishment of an adequate medical service in industrial plants, as follows: the reduction of the labor turnover, the placement of men where best suited, the control of fatigue, the uncovering of unhygienic conditions in the plant, a promotion of the feeling of security among the employees, the study of accident prevention, the early treatment of trauma, medical care during working hours, discovering and checking epidemics, and removing the causes of occupational diseases.

Economy of man power demands industrial medical service to help in the removal of causes of accident, excessive labor turnover and occupational diseases. — Elinor D. Gregg.

Physical Examination for Employees. *C. M. Douthitt.* Finance and Industry, Oct. 2, 1920, 23, 29. — Many of the larger industries have installed a more or less complete medical service and have found it economically profitable. If the experiment is a failure it is due usually to the selection of a poor physician. The greatest weakness of industrial health service at present is its tendency to care only for the sick and injured, without due attention to the prevention of sickness. The majority of cases of sickness found are due to colds, constipation, indigestion, etc. These slight but troublesome ills cause about nine-tenths of lost time due to sickness. Compulsory examination will not be objected to by employees when they realize it is for their good. — L. A. Shaw.

Plant Dispensary Saves Employes' Time. *DeWitt Broughton.* Hosp. Management, June, 1920, 9, No. 6, 58, 60. — The medical organization of the Brown-Lipe-Chapin Company, a gear factory employing slightly under 3000 workmen, consists of a physician, a nurse, and two first-aid attendants. This organization is able to benefit the company in the following manner: (1) It assigns applicants to work for which they are physically best adapted. (2) It prevents employment of applicants who are costly for the company to carry. (3) It reduces the number of men out of work by timely treatment of cases of injury. (4) It reduces the time lost by accidents by providing light work for the injured until complete recovery has been effected. — L. A. Shaw.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

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## CONTENTS



## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

A RARE DISEASE. Bull. N. Y. State Indust. Com., Nov., 1920, 6, No. 2, 22. — Two men employed in the coating room of the Dupont Fabrikoid Company works in West Newburgh died of a comparatively rare disease known as "purpura hemorrhagica," which so decreases the volume of white corpuscles in the blood as to destroy the power of coagulation, so that the patient bleeds from the mucous membrane. It was asserted that in the Newburgh cases the disease was caused by the poisonous fumes of benzol, and that the company had not taken proper precautions to dissipate these fumes by the placing of fans and ventilators — an assertion which the company denies. It was reported that other men in the coating room had had nose bleeding, but, on the other hand, it is maintained that some men now on the payroll of the company have worked regularly in the coating room for fifteen years without suffering any bad effects from their work. — G. E. Partridge.

THE HYGIENIC CONDITIONS IN THE SULPHUR INDUSTRY OF CATANIA. *G. Sangiorgi.* Abstracted as follows from Rivista di Ingegneria Sanitaria e di Edilizia moderna, 1919, No. 5, 21, 22, in Il Lavoro, Oct. 31, 1920, 11, No. 6, 186–188. The author describes conditions in the sulphur works of Catania where the occupational diseases are similar to those found in the sulphur mines, but the dangers are greater in the mines because of the presence of carbon dioxide and hydrogen sulphide, the great humidity, high temperature, and poor ventilation. The only poisonous elements in the sulphur factories are sulphur dioxide and sulphur dust. According to Lehmann, sulphur dioxide is irritating when present in 0.006 to 0.01 per cent. and may cause serious disturbance in the proportion of 0.03 per cent. The powdered sulphur has, in addition to an irritating action on the eyes and nasal and bronchial mucosa, a slower but more serious effect on the lungs which shows itself in a chronic indurative proc-

ess, as a consequence of which part of the lung is devoid of function. Pulmonary tuberculosis should be considered as an occupational disease of these workmen. The age at which boys may enter this industry, now 15 years, should be raised. — Alice Hamilton.

Experience with Combined Poisons in Industry. *Müller.* Abstracted as follows from Zentralbl. f. Gewerbehyg., 1919, 7, pp. 57, 73, 97, 113, 138, in Hyg. Rundschau, Feb. 1, 1920, 30, No. 3, 85–86. — "Tables show that in some industries a variety of poisonous substances are used and many possibilities exist of simultaneous or consecutive action of poisons. Mixtures of dangerous substances may form new poisons; the susceptibility of the body to one poison can be altered by contact with another. Combined poisoning is apt to occur in paint or cement works and especially in furrier's work. Since the furrier's macerating liquor contains mercury, mercuric chloride, nitric acid, and arsenic, an interaction of the results is not surprising. Technicians for scientific institutions are not infrequently made ill by their contact with many poisons. The author mentions as an example an anatomical technician who injected blood vessels with a mass containing carbon bisulphide, red lead, mercuric chloride, and carbolic acid.

"Change of work, impure products, and changes of procedure especially favor the appearance of combined poisoning. The author cites examples of all three possibilities. Solvents for varnish, colors or celluloid are almost always mixtures. Striking attacks of illness in a factory, beginning with inflammation of the eyes and clouding of the cornea, were explained by the composition of a leather varnish, which contained acetone, methyl alcohol, formaldehyde, nitrobenzene, aniline, and extraordinarily much chlorine (chloracetone is a very poisonous substance). During the war substitute products contained many poisonous substances. Shoe-creams contained large amounts of nitrobenzene. The comparatively harmless toluenes are often mixed with tetranitromethane. The carbon used in the electrochemical industry contains phosphorus and sulphur, hence the acetylene produced is contaminated with hydrogen sulphide and phosphine, thus giving occasion to poisoning.

"Carbon monoxide plays a large rôle in combined poisoning. Bad quality of the coal and coke mixtures increases this danger. As a result of the combination of different intoxications the syndromes are often atypical. In the combustion of celluloid there appear vapors of carbon monoxide, nitrogen, the two forms of nitrogen tetroxide ($NO_2$ and $N_2O_4$), and hydrocyanic acid, which at times, with the bad conditions of buildings, lead to intoxication. In the pharmaceutical industry unforeseen poisonings often occurred since a change in the product had to be made.

"Animal experiments have shown that the respiration of toxic gases makes animals less resistant to infections. Men show the same reaction. Also poisons more readily affect the organism chronically weakened by age, overtiring, anemia and other illnesses. Alcoholism makes the body most sensitive to poisoning by many substances, as for instance cyanamide, zinc, aniline, and mercury. Just like the bodies damaged by alcoholism and other habitual poisons, the organism weakened by lead industries is subject to the possibilities of other poisonings. The author cites several examples. He emphasizes the necessity for the physician, when taking a history from a sick person, to inquire in detail into the industrial environment, not contenting himself with the statements made by the worker or the manager of the industry. Pursuits that have been considered safe for years may become dangerous through the impurity of materials or slight changes in the processes. After having established the occurrence of one poison, one must guard oneself against overlooking the action of a second and perhaps more powerful poison, which frequently happens in cases of carbon monoxide poisoning. Insufficient study of a case may prejudice a worker in his claims for legal insurance." — E. L. Sevringhaus.

Medical Discretion in Industrial Poisonings. *Curschmann.* Abstracted as follows from Zentralbl. f. Gewerbehyg., 1919, 7, pp. 131, 145, 171, 191, in Hyg. Rundschau, July 1, 1920, 30, No. 13, 407–408. — "A molder in a brass foundry felt ill on the evening of the day after an alcoholic excess, was mildly stupefied, and had to be taken home, where he died the following day. Carbon monoxide was found in his blood. The technical construction of the foundry was free from objection. Poisonings had not been observed on the day of the accident or before by the management of the works. The clinical course gave no indication of the

symptoms of the well-known carbon monoxide poisoning. The author believes, therefore, that in spite of the carbon monoxide demonstrated in the blood, the poisoning with carbon monoxide may be ruled out, and considers it more probable that the death is to be referred to the harm from the alcohol plus the methyl alcohol which was so frequently admixed during the war. Animal experiments as well as the findings in one patient known to have taken methyl alcohol demonstrate that after poisoning with methyl alcohol carbon monoxide may be found in the blood.

"A soldier-workman, employed for weeks in a trinitrotoluol factory, was engaged in emptying a container which held trinitrotoluol and benzene. He suddenly fell and was dead although help was immediately at hand. Postmortem sections showed normal findings in the internal organs, the heart was flaccid and without pathological changes. In the upper arm was a large hemorrhage, the brain showed many punctate hemorrhages, and an aromatic odor was connected with the respiratory passages. It is known that benzene vapors can have fatal results in a very short time and that in such cases death comes with no preceding symptoms, and above all that the affected person cannot make an attempt to get out of the dangerous atmosphere. The blood change from absorption of benzene acts upon the vagus center so that cardiac action stops. Death is a kind of shock action. If the heart is not completely resistant or is subject to special demands as during the stage of digestion an exciting cause is furnished. The postmortem findings are not characteristic; bright color of the blood, congestion of the brain, extravasations, and the benzene-like odor of the respiratory organs are mentioned. The soldier-workman, who was the victim of the poisoning, was of reduced resistance and was at the time in the stage of digestion. Death was caused by inspiration of benzene fumes." — E. L. Sevringhaus.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Paraffinoma and Wax Cancer. *B. F. Davis.* Jour. Am. Med. Assn., Dec. 18, 1920, 75, No. 25, 1709–1711. — "A woman, aged 30, referred by Dr. Oliver Ormsby in June, 1918, had become annoyed in June, 1916, by a couple of small moles of approximately symmetrical location on each cheek. These had been removed by electrolysis, leaving small, depressed scars. Paraffin had then been injected by a so-called beauty specialist to fill out the depressions; the immediate results were so pleasing that several small wrinkles on each cheek had also been filled out at subsequent sittings. In about a year the site of the injections became slightly swollen, indurated, and assumed a dusky red color. The induration and discoloration gradually spread to involve the greater part of each cheek lying between the angle of the mouth anteriorly, the zygoma above, the anterior border of the masseter muscle posteriorly, and the mandibular margin below. It became impossible to open the mouth more than one-half inch. The induration transformed the smooth convexity of the cheeks which had immediately followed the paraffin injections into pronounced concavities. At frequent intervals the lesions became the seat of mild suppurative processes associated with the extrusion of minute particles resembling paraffin; these would leave small ulcers which would crust over, heal, and again break down, so that there was an almost constant discharge from areas involved. . . ."

"There were three reasons for operating: to (1) reduce disfigurement; (2) increase the mobility of the mandible, and (3) forestall epithelioma. The treatment adopted was complete excision of involved tissue and substitution of a flap of skin and fat removed from the arm, one side at a time. This involved four different operations. At the first operation, the lesion on the right cheek was excised, the dissection being carried to the mucous membrane at one point; the right arm was brought up over the head and a pedicled flap from the arm stitched into the cheek defect. The position of the arm was maintained by a plaster cast for two weeks when, under gas-oxygen anesthesia, the cast was removed, the pedicle of the flap cut, and the arm brought down to the side. The stump of the transplant on the cheek was then sutured in position. Ten days later the procedure was repeated on the opposite side. Healing in each instance was uneventful. The result when the patient was last seen, that is, eight months after operation, was a decided success from the standpoint of each of the three objectives of treatment. . . ."

"We may say that paraffinoma is a chronic granuloma produced by prolonged, continuous exposure of susceptible tissues to the irritation of paraffin. Disfigurement, deformity, and interference with function, if the lesion is in a region requiring motility, are the chief types of disability resulting; cancerous degeneration, "wax cancer," is an occasional intruder. Complete extirpation of the involved tissue is the treatment of choice. Paraffinoma probably is not the expression of a specific growth-inciting property of paraffin, but is rather the result of the long continued action of a low grade chemical irritant." — C. K. Drinker.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Use of Stenches as a Warning in Mines. *S. H. Katz, V. C. Allison,* and *W. L. Egy.* U. S. Bur. Mines, Tech. Paper No. 244, 1920, pp. 31. — The summary of the paper is as follows:

"1. The placing of stenches in the compressed-air lines of a mine, to warn miners of danger, offers certain advantages over the use of electric bells or other means of warning. Among these advantages are convenience of installation, reliability of action, and positive effect upon the miners, the natural instinct being to flee from the ill-smelling air to pure air." The necessary properties of stenches are nontoxicity, moderate vapor pressure, odor (which should be disagreeable), and availability.

"2. An apparatus or 'odormeter' for measuring intensity of odors was devised for the laboratory examination of various stenches.

"3. Of 24 chemicals examined, butyl mercaptan, ethyl mercaptan, amyl acetate, butyric acid, and valeric acid were found most promising for mine warnings.

"4. Tests performed in mines showed that a quick and positive warning could be given with these materials.

"5. A simple apparatus, or injector, has been devised for introducing the liquid chemicals into compressed-air lines of mines.

"6. Instructions for the use of the chemicals and the injector have been given.

"7. It is important that good ventilation be established to clear mines of the stench after a warning." — M. Dent.

Prevention of Gas Explosions in Bituminous Coal Mines. *R. A. Walter.* Safety Engin., Oct., 1920, 40, No. 4, 173-177. — Gas explosions in bituminous coal mines can be prevented by providing such ventilating current under proper control as will dilute to a harmless mixture and carry away all explosive gases, and by preventing all contact between dangerously gas-laden mine air and flames or sparks sufficiently hot and sustained to cause ignition.

*Ventilation.* — There must be delivered at the working face 150 cubic feet of air per minute for every man, and 500 cubic feet for every mule, with such further volume as may be necessary to dilute to $\frac{1}{2}$ of 1 per cent. the gas content in individual splits, and to $\frac{1}{3}$ of 1 per cent. the gas content in the entire return from the mine. Too much importance cannot be placed on proper proportioning of air courses and the construction of overcasts, stoppings, regulators, brattices and doors. Splits should be taken off with relation to gas transpired, number of men worked, air velocity and location of old workings. Rules are given for the construction of regulators and brattices, automatic doors, and splits, and for the provision of skilled fire bosses.

*Precautionary Measures.* — These concern explosives, shot firing systems, tamping, open lamps, machinery, fires, electric locomotives, switches, fuses, etc.

The author concludes with the statement that enormous unnecessary waste in money and life occurs every year owing to poor ventilating systems and poorly thought-out safety measures. — M. Dent.

Accident Prevention in the Mines of Butte, Montana. *Daniel Harrington.* U. S. Bur. Mines, Tech. Paper No. 229, 1920, pp. 57. — This careful report is based on data obtained in 1916, 1917, and 1918 by personal observation and study. Much time was spent underground and more than twenty of the larger mines were thoroughly examined.

Safety organization is described. Causes of accidents are analyzed. One serious difficulty in developing safety work is the rapid turnover of labor at Butte. This has amounted to 50 per cent. or more per month. Measures to prevent this are suggested. — H. S. Forbes.

Accidents in Mines and on Railroads in the United Kingdom in 1919. U. S. Bur.

Labor Statis., Month. Labor Rev., Dec., 1920, 11, No. 6, 133–134. — A summary from the report of the chief inspector of mines for Great Britain shows a total of 123,454 accidents in quarries and mines in Great Britain and Ireland (including for quarries the Isle of Man) during the year 1919. Of these accidents, 1,229 were fatal. The figures are given separately for coal mines, metalliferous mines and quarries, and accidents are classified in main groups. The falling of ground was responsible for 42,518 non-fatal and 589 fatal accidents in the coal mines in that year, and there were about 11,000 surface accidents connected with these mines. Shaft accidents and explosions make relatively a very small number, and about half of the accidents in the coal mines are grouped as miscellaneous underground accidents. Accidents in the metalliferous mines show a somewhat different distribution, but these altogether make but about 3 per cent. of all the accidents. Fatality rates for 1918 and 1919 are given for each type of accident for the three groups separately, and these figures are computed on the basis of 1,191,313 employees in the coal mines, 21,661 in the metalliferous mines, and 57,076 in the quarries. — G. E. Partridge.

## WOMEN AND CHILDREN IN INDUSTRY

Work Accidents among Women. *Nelle Swartz.* Bull. N. Y. State Indust. Com., Dec., 1920, 6, No. 3, 56–57. — In this paper which was read before the Fifth Industrial Congress at Syracuse, Dec. 7, 1920, the author states that of the known accidents in industry, about 95 per cent. are accidents to men, although men comprise only about 70 per cent. of the total working population. Very little being known about work accidents among women as distinguished from accidents among men, Miss Swartz undertook to study 1,000 compensated accident cases among women occurring during the period from June 1, 1917 to June 1, 1918. Six industries or industrial groups were chosen: metal, textile, clothing, paper products, printing, and a mixed group which included 12 per cent. of the cases; of all the cases it was found that about one-half fell to the metal and textile trades.

Various factors in the causation of accidents were found. Inability to speak English is one. Of the accidents studied, 18 per cent. occurred to women who had been with their employers less than a month, and about 63 per cent. to women who had been with their employers less than a year. Almost half of the women were less than 20 years of age. Twenty-eight per cent. of the accidents happened to married women, although married women constituted only 10 per cent. of the total number of the women, and it is suggested that the combination of shop work with domestic work, with its inevitable fatigue, is a factor in this result. Almost 90 per cent. of the injured women were receiving less than $15 per week, and more than 50 per cent. were receiving less than $10.

The greatest number of accidents are caused by machinery and are particularly numerous in the metal industry where presses are especially hazardous. The sewing machine causes many accidents in the clothing trades. In the paper trade the most dangerous machine is the corner stayer. Stumbling and falling accidents made the largest class with the exception of machine accidents, comprising about 17 per cent. of the whole. Poor lighting and bad construction of staircases are in part responsible, but the factor of fatigue must also be considered. Less than 2 per cent. of all the accidents can be traced directly to clothing.

As to accident prevention, it may be said, first, that we have passed the point when women should be prohibited from working on certain kinds of machinery because these machines are dangerous; instead, the machines should be made safer. In the next place, it may be urged that women ought to be taken more into consideration in the safety movement. Safety experts maintain that not more than 25 or 33 per cent. of accidents can be prevented by safety devices, indicating that training is needed quite as much by women as by men. Since fatigue is probably a more important factor in causing accidents among women than among men, fatigue should be better understood and controlled with reference to accident prevention among women. Rest periods, reduction of hours of work, change of processes during the day must be provided for. — G. E. Partridge.

Tenement Homework in New York City. *Mary G. Schonberg.* Am. Child, Nov., 1920, 2,

No. 3, 257–261. — The homes of 500 families in which home work was being done were visited for the purposes of the study. The families were distributed in different parts of the city, and the work engaged in was varied. Most of the home workers are mothers, and, as a consequence, they not only become nervously and mentally exhausted, but also neglect their house-work and their children. As to the employment of children, it is impossible to obtain accurate figures, but there are many signs of overworked children, and of children who suffer indirectly from home work. "The story of the child in the tenement is one long tale of neglect, undernourishment and overwork, and . . . every argument directed against child labor in the factory applies even more strongly to child labor in the home, because of the peculiarly adverse conditions under which these children work." The ordinary licensing and inspection are wholly inadequate to meet the requirements, and there is needed a long campaign of education and publicity that such legislation may be enacted as will abolish altogether this iniquitous and now unnecessary phase of industry. — G. E. Partridge.

Maternity and Labor. *V. Fraschetti.* Abstracted as follows from Bollettino dell' Ufficio Municipale del Lavoro di Roma in Il Lavoro, Dec. 31, 1920, 11, No. 8, 247–250. — The following table is based on 13,865 births which occurred in the six years, 1912 to 1918 inclusive, in three maternity hospitals in Rome. The figures represent average weight in grams of the children at birth.

| Employment of Mother | Weight of Offspring |
|---|---|
| Sick nurses | 3,317 |
| Hotel chambermaids | 3,285 |
| Fruit venders | 3,264 |
| Cooks | 3,224 |
| Laundresses | 3,224 |
| Peasant women | 3,218 |
| Performers in theatres and cafés chantants | 3,192 |
| Domestic servants | 3,168 |
| Janitresses | 3,166 |
| Tailors | 3,134 |
| Pressers | 3,091 |
| Tenement house workers | 3,079 |
| Metal polishers | 3,033 |
| Printers | 2,929 |
| Machinists (making projectiles) | 2,880 |
| Employees on tramways | 2,204 |

— A. Hamilton.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Effective Printing-Plant Illumination. *A. D. Bell.* Electrical World, Dec. 11, 1920, 76, No. 24, 1153–1155. — In discussing the methods of laying out an effective lighting system for printing establishments the writer pays particular attention to abundance of light, avoidance of glare and shadows, simplicity and uniformity of design. — G. M. Fair.

Deterioration of the Air in Closed Rooms on Naval Vessels with Especial Reference to Battle Conditions. *Bathe.* Abstracted as follows from the original — a 75-page illustrated booklet from the press of Gustav Fischer, Jena, 1920, No. 2 of the marine medical experiences of the war, published by the medical division of the admiralty — by Martini in Hyg. Rundschau, June 1, 1920, 30, No. 11, 342. — "During the war the author arranged a series of experiments in certain closed rooms on battleships which were designed to have artificial ventilation in order to make possible the continued occupancy by men. By simultaneous attention to the chemical and the physical conditions with reference to the habitability of the experimental rooms it was found that the former factors lay far behind the latter in their harmful effect. It is not the carbon dioxide but the humidity, together with the high temperatures, which renders life so soon impossible in these rooms which are so important for the ship if, for example, during a battle the ventilation apparatus must be protected from the poisonous gases incidental to the explosion of shells. Unfortunately the ventilation method must suffice (although the arrangement could be improved in its effectiveness) as long as a better means for the removal of moisture is not found." — E. L. Sevringhaus.

Determination of Atmospheric Impurities. *Osborn Monnett.* Chem. and Metall. Engin., Dec. 8, 1920, 23, No. 23, 1117–1121; Dec. 15, 1920, No. 24, 1173–1176. — This is a study of the character and amounts of atmospheric impurities in the air of Salt Lake City. It includes (1) the estimation of solids and gases present including sulphur dioxide and

smelter gas and (2) a soot fall study in which material settling at different locations was measured and analyzed at monthly intervals of time.

The author summarizes his results as follows:

1. The concentration of solids in the atmosphere varied from less than 0.1 mg. to 2.5 mg. per cubic meter. The highest amount occurred during the heating season and in the business district. In this heating season the solids originated practically entirely from fuel.

2. The total soot fall during the heating season averaged about 250 tons per square mile per annum. Ninety-five tons or about 40 per cent. of this material was combustible matter.

3. Sulphur dioxide determinations showed an average concentration of 0.15 parts per million during December and January, and 0.10 parts per million during March. The presence of the gas was due to combustion of coal in the city. It was a negligible factor in the smoke nuisance.

4. The smoke concentration and soot fall was as high as that observed in cities consuming five to ten times as much coal yearly.

Some of the methods used in determining these factors should be of interest to industrial hygienists. — G. M. Fair.

Pure Drinking Water for Industrial Plants. *Arthur M. Buswell.* Nat. Safety News, Sept. 6, 1920, 2, No. 10, 12; Nov. 1, 1920, No. 18, 13. — Damage suits have been paid by a corporation in the west for damages resulting in sickness and death from typhoid fever contracted from impure drinking water. The ruling of the Wisconsin Supreme Court that contaminated drinking water was an accident for which the employer is financially liable would be upheld under most workmen's compensation acts.

Typhoid fever is our most prevalent waterborne disease. The yearly cost of typhoid fever is \$150,000,000. So much difficulty is found in obtaining pure drinking water from city supplies that it behooves employers to look carefully to the purity of their water supply.

The methods of water purification are given in outline:

For clarification:

1. Filters of porous material. Impractical for large amounts of water.

2. Sand filters.
   - (a) Slow gravity type without chemical coagulant. Requires too much space.
   - (b) Mechanical pressure type with chemical coagulant. Practical but incomplete without subsequent sterilization.

For sterilization:

1. Chlorination. Cheap, and effective if chloramine is used, but requires about thirty minutes before the action is complete. There is frequently a disagreeable taste and odor.

2. Ultra violet ray. The ultra violet ray is effective immediately and once adjusted does not vary in effectiveness, as no human equation is involved. — Elinor D. Gregg.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

The Medical Department of the Fulton Bag and Cotton Mills. *D. T. Heyser.* Mod. Med., Oct., 1920, 2, No. 10, 673–674. — This is an article describing an industrial medical department which conducts unusually extensive and varied work. This department undertakes to care for families of employees as well as for the workers themselves. A small hospital is maintained with resident physician and nurse. Two nurses of the staff devote most of their time to visiting the homes of employees, doing actual bedside nursing and giving instruction in hygiene. The physician also visits employees or their families in the home. As a part of the hospital service a dental clinic is maintained as well as the usual first-aid rooms.

Among the special activities of the medical service are: nutrition classes for children; nasopharyngeal clinics conducted by visiting specialists; a baby hygiene clinic; a day nursery; prenatal instruction in connection with the maternity work of the hospital; and a clinic for venereal treatment. — H. W. Stevens.

The Medical Unit of a Factory. *R. Rapp.* Month. Bull. N. Y. City Dept. Health, Aug., 1920, 10, No. 8, 187–189. — A medical unit is needed in every factory because of major and minor injuries which, despite automatic safeguards and safety bulletins, are certain to occur in operating high velocity machinery. Saving of time through prompt and effective

attention in cases of illness, examination of physical and mental condition, which leads to the redistribution of workers, etc., are functions and results of the medical work. The proper personnel consists of an industrial physician, an industrial nurse or nurses, first aid, a clerk, a superintendent or manager *ex officio*, and a visiting dentist. The work of the industrial physician should be done with attention to the value of routine and system. The nurse must be equally efficient and orderly, and, in addition to her purely professional work as assistant, she should confer with foremen, take an initiative in discovering needs, and clear up misunderstandings between doctor and patients. The first-aid man should be able to apply artificial respiration, control hemorrhages, and do antiseptic dressing. Others who are factors in the medical work must also take their functions seriously, and be reliable and discreet. Equipment must be adequate, and all the details of the work attended to in a business-like manner. — G. E. Partridge.

Medical Service of the Gillette Company. Hosp. Management, Oct., 1920, 10, No. 4, 64. — The plant hospital of this company has a very low daily average of cases, due to precautions taken against accidents and to the attention given to health conservation, such as drinking fountains, scientific ventilation, etc. — L. A. Shaw.

Comprehensive Service for Employees. *Charles H. Lemon.* Hosp. Management, Oct., 1920, 10, No. 4, 66. — The Milwaukee Electric Railway and Light Company and its Employee's Mutual Benefit Association furnish to the employee, his wife, and his dependents under 18 years of age, everything that they need in the way of medical service. The doctors forming the personnel are experts in the lines for which they are chosen. The service rendered is comprehensive, acute as well as chronic ailments being treated. The service thus given is preventive as well as curative. Statistics of the company show a reduction from the former average disability of nine days per man per year to a little over four days per man per year. Through such a system the man is kept contented with his work, his family life is greatly improved, and his average medical expenses are much reduced. — L. A. Shaw.

132,913 Sick and Injury Cases in a Year. *J. L. Bower.* Hosp. Management, July, 1920, 10, No. 1, 56–58. — The Pennsylvania Railroad Company lays great stress on first-aid work which, by direction of the management, has been placed under the jurisdiction of its relief department. First-aid packets are widely distributed, and at industrial centers, such as shops, fully equipped first-aid rooms have been established with a properly trained man in constant attendance and with a daily visit by the medical examiner. First-aid corps, instructed by the medical corps, have been established at all points where first-aid cabinets have been placed. Sanitary inspection of camps, dormitories and other places is a part of the routine duty.

The recent establishment of an eye department equipped to treat diseases of the eye and especially to correct refractive errors has proved a valuable addition to the company's medical service. In the near future, the company contemplates placing similarly equipped eye establishments at several of the large terminals for the greater use and convenience of all needing such help. — L. A. Shaw.

High Standards in Health Care at Hotel McAlpin. *Samuel H. MacFarlane.* Mod. Med., Oct., 1920, 2, No. 10, 667. — Recent expansion of medical service has developed hospital service for hotels. "The Hotel McAlpin has a completely equipped hospital, modern in every respect" in charge of a physician and a well-trained nurse. The service of the hospital is available to guests as well as to employees.

Daily clinics are held from 9 to 10.30 mornings and from 5 to 6 evenings; and emergency treatment is given immediately when required. Physical examinations are made of all employees, especial attention being given to those working with food or in the laundries.

A social worker who is a graduate nurse visits all workers absent because of illness.

A sanitarian and food chemist works in conjunction with the hospital service. Her work comprises inspection and testing of all foods used. Manicuring of all cooks, waiters and food handlers is also a part of her daily program. Several other hotels are served by the same food chemist.

The writer quotes an extract from a report of an inspection of the McAlpin made by the N. Y. City Department of Health: "We found measures taken for the sanitary handling and preparation of food and personal care of em-

ployees that we did not believe to exist in any institution in the country." — H. W. Stevens.

How Can Medical Service Be Improved? *F. H. Thompson*. Proc. 6th Ann. Meeting Internat. Assn. Indust. Accident Boards and Commissions, U. S. Bur. Labor Statis., Bull. No. 273, Aug., 1920, 295–299. — Pay a better fee for skilled service and thus secure the best possible service. Give the industrial boards broader power to regulate services and to make certain rules to enforce them. Induce a clearer understanding between the medical profession and the industrial board. Encourage reconstruction of injured workmen and through investigation, etc., place the man in competent hands as early as possible. Eliminate the pernicious contract system for medical service in industrial work. — Barnett Cohen.

How the Factory Dentist Earns his Salary. *E. F. Bowers*. Factory, July 15, 1920, 25, No. 2, 219. — The establishment of dental infirmaries in connection with industrial enterprises is being looked upon today as an economic necessity. Not only is there an immense saving in dental fees to the employee, but there is an enormous saving in time which operates to the advantage of the employer, for bad teeth mean lowered vitality and often illness. — L. A. Shaw.

Industrial Dental Dispensaries. *Sanford DeHart*. Am. Machinist, Dec. 9, 1920, 53, No. 24, 1085–1086. — A description of the dental dispensary of the R. K. LeBlond Machine Tool Company, together with recommendations based upon the experiences obtained in its operation. — G. M. Fair.

## INDUSTRIAL NURSING

Relation of Industrial Nurse to Employment Manager. *Elizabeth Ross*. Pub. Health Nurse, Nov., 1920, 12, No. 11, 948–950. — This is a discussion of a previous paper, in which a writer advocated making the position of industrial nurse a stepping stone to the position of employment manager. The present writer thinks that it is important to keep the industrial nurse within the bounds of her own profession. A possible line of advancement would be in establishing better relations between the industrial nurse and the employment manager. In most industries a real health conservation department does not exist. Nurses complain that they are obliged to use indirect methods to gain recognition of their work, and that the nurse's position is generally very indefinitely defined and very variable. She may be merely a hospital worker, her activities confined to her assigned room; or she may be regarded in the light of a truant officer, spending her time in investigating absenteeism; or she may be called upon to run a restaurant, a library, or a company boarding house, or to take charge of a general social program—all of these valuable services which the nurse is able to perform, in so far as they do not demand methods incompatible with professional ethics.

At the present time there are many nurses engaged in industrial nursing, who lack knowledge of social and industrial conditions and have low ideals in regard to their work. After all, however, it is the management that is to blame. Industry needs our best women, and this need should be recognized fully; these women should be well trained, and should be given opportunity and freedom to do their work in the most efficient manner.—G. E. Partridge.

Why Nurses Fail in Industrial Work. *O. F. Scott*. Pub. Health Nurse, March, 1920, 12, No. 3, 223–228. — The troubles of the medical department in industrial work arise very frequently from lack of co-operation either in the employment department or in the service department. The industrial physician and the industrial nurse are perhaps not in accord, or there may be a lack of understanding between the managers of the employment or the service department and the industrial nurse or physician. The only remedy is to secure the necessary co-operation; and for this there is required patient and tactful effort on the part of the industrial nurse. Failure confronts the nurse in two directions: She may fail to make headway in removing opposition, and consequently fall back into an ineffectual way of working; or she may inspire dislike and in that way lose her hold upon the situation. What is needed is personality.

The nurse in the industrial plant at the present time must often do without adequate equipment and work in poor quarters, since it is the tendency to disregard the needs of the

medical department in the industrial service. The nurse must bend her efforts toward obtaining for her work proper sanitary space, efficient standardized equipment, and authority for supervision in her own department. — G. E. Partridge.

Suggestions for the Industrial Nurse. *Christine R. Kefauver.* Am. Jour. Nursing, Nov., 1920, 21, No. 2, 77–80. — Among the functions of the industrial nurse as indicated by this article are (1) setting a proper example to other women employed in the plant by the wearing of the simple form of dress which is characteristic of the nurse's uniform; (2) the rendering of first aid; (3) investigations of conditions which lead to absenteeism and labor turnover; (4) supervision of home conditions where needed; (5) inspection of sanitary conditions within the plant; (6) education of workers in health, sex hygiene, etc., through talks; (7) proper understanding of industrial processes so as to be able to recommend the improvement of working conditions both from the health and the safety standpoint. — C. H. Paull.

## INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

How Showers Improve Morale. Factory, Dec. 15, 1920, 25, No. 12, 1910. — The installation of shower baths for employees has been found profitable by many successful concerns which are making progress in maintaining the health of their employees. — L. A. Shaw.

How Eleven Manufacturers Combined for Better Housing. *Con De Pree.* Factory, Oct. 15, 1920, 24, No. 8, 1226–1227. — The writer outlines a housing development plan in which the industries in the community furnished capital for a home building association. This association carries on its activities with no overhead expense. Instead of building its houses in one locality it is scattering them in the community, thereby eliminating the necessity for great variety in structure. At the outset nine plans were drawn, thus permitting a sufficient variety so that where several houses were located near together the danger of monotony was eliminated. The houses are of two types, a one-story bungalow selling for from \$4000 to \$4500, and a two-story house selling for from \$5000 to \$5500, the variation in cost depending largely upon the purchasing price of the land. — C. H. Paull.

Model Building Regulations of the State Commissioner of Housing of April 25, 1919. *Tittler.* Zentralbl. f. Gewerbehyg., Oct., 1920, 8, No. 10, 197–200. — In the model building code of April 25, 1919 of the state commission for housing in Prussia are many points of interest to workers.

Provisions for building permits have undergone extension, and now include not only all new buildings and existing buildings subject to remodelling, but also restoration of gas furnaces, electric installations and motors. All quarters which are used for industrial purposes, before undergoing remodelling, the fitting up of rooms for human habitation, and the specifications for warehouses, fall within the scope of the extended regulations. The term "fireproof" has also been accurately defined by the new code. For factory buildings, special regulations are made for fireproofing of walls, fire engine service, exits and air, gas and sewage disposal. Distances between factory buildings must be at least 5 meters and if occupied by workers must be separated by a distance half the height of the buildings. Special localities for factory buildings are designated. Dispensations and some exceptions will be permitted.

For the protection of workers regulations are made relative to *per capita* space allotments in all buildings designated "for the continuous presence of human beings." In this category are included shops, business offices, workers' rest rooms, bureaus and stores. Such places must be protected against dampness and untoward weather conditions. Lighting regulations are not particularly specified. A minimum of $2\frac{3}{4}$ meters is set for houses of two to three stories; those with two stories or less, $2\frac{1}{2}$ meters. Top floor rooms need be only 2.2 meters high. The author, however, believes that the regulations ought to demand a minimum of 3 meters in all cases. (*Continued.*) — H. V. Williams.

Model Building Regulations of the State Commissioner of Housing of April 25, 1919. *Tittler.* Zentralbl. f. Gewerbehyg., Nov., 1920, 8, No. 11, 208–212. (*Conclusion.*) — The following conditions are prescribed for

rooms designated "for the continuous presence of human beings." Floors are to be at least 0.4 meters above the level of ground water. No such rooms may be in the cellar of a small house. A cellar is the floor below the first full story, which latter must not be over 0.4 meters below the surface of the ground. It is forbidden to erect buildings for continued occupancy on the ground floor except in certain cases, where the lighting is specified as not from the north and at not less than 45 degrees. There is no provision that working rooms be not over 9.5 meters below the surface.

Floors must be of wood or other washable material. Halls must be sufficiently well lighted and ventilated. Rooms may be used for storage or work with dwelling rooms above, only if there is a fireproof and vapor proof floor between and a separate and fireproof stairway. Steam apparatus and internal combustion engines must have special vents.

Water supply is guarded. Springs must be at least 10 meters from certain listed sources of pollution; 5 meters is permitted in soils that are impervious. In large buildings water must be piped. Every working place must have a privy provided. Protection must be afforded against falling glass unless wire glass is used. Provisions are made for protection of workers on building construction.

Firewalls are required to separate rooms with any fire risks and must be at intervals of not over 40 meters in extensive buildings. Wooden raftered roofs must be plastered. Stairways must not be over 25 meters from the center of a room. Distances between woodwork and smoke pipes and fireplaces are prescribed. All buildings must border on an open street. The distance between buildings is set at 2 to 5 meters at least, according to illumination and fire hazard.

Provision is made for establishing districts where only industrial buildings may be erected. Machinery causing noise or vibration must not be fastened to walls which will conduct the disturbance to dwelling rooms. Chimneys must be high enough to carry off smoke, soot and dust. Spark catchers are required in certain cases. Sewage connections are required for factories. Liquids dangerous to health must be properly disposed of.

It is considered highly desirable that in framing such a code there should be more co-operation between the building regulation officials and the industrial inspection officers. — E. L. Sevringhaus.

Providing Homes for the Workers. *J. S. Smith.* Abstracted as follows from Manufacturers' News, 18, No. 8, in Business Digest Service, Oct. Month. Cumulation, Executive Management and Accounting Section, Oct. 27, 1920, 26, No. 17. — "Through the activities of the General Motors Corporation at Flint and Pontiac, Michigan, a company known as the Modern Housing Corportion has been formed for building workers' homes on a large scale and at low cost.

"Each employee who buys a home which costs from \$3500 to \$8500 from this corporation has paid for him, by the General Motors Corporation, \$800 to be used as part of his first payment. This money is a gift, but in return the employee agrees to allow the company to purchase the house of him and return the money (not including the \$800) he has paid for principal, interest, taxes, assessments, and insurance. He will be charged a sum equal to rent at the rate of 10 per cent. per annum on the selling price mentioned in the contract, in case he resigns, is discharged, or dies within five years from the date of purchase. The purchaser of a home from the Modern Housing Corporation is required to make a cash payment of at least 5 per cent. of the purchase price. After that he is required to devote at least 25 per cent. of his earnings each year to payments of principal, interest, taxes, and fire insurance until the building is entirely paid for. After deducting the estimated cost of insurance and taxes the balance of the 25 per cent. is divided into twelve equal parts which represent the monthly instalments. The average buyer will pay for his house in ten years." — M. C. Shorley.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

Preliminary Notes on the Boot and Shoe Industry. *J. Loveday* and *S. H. Munro.* Industrial Fatigue Research Board, Report No. 10. Boot and Shoe Series No. 1, His Majesty's Stationery Office, London, 1920, pp. 32. — This report is divided into four sections: the first, an historical sketch of the boot and shoe industry in England; the second, a description of the processes of boot and shoe making; the third, an account of an investigation of daily

output of several factories; and the final section, a report of an experiment on rest pauses.

The analysis of records of daily output, which in many industries has yielded information of great value, has proved somewhat disappointing when applied to the boot and shoe industry. Boot and shoe factories are usually comparatively small; none of the operations, except one or two minor processes, are strictly automatic; the industry is essentially a "following-on" manufacture, the worker's output being determined in part by what is done in preceding processes. Records were obtained from five factories, all of which showed a low output on Saturday as compared with other days of the week. Some manufacturers, recognizing this fact, have abandoned Saturday work altogether, and it is their experience that Friday's output does not fall off to the same extent as does Saturday's output under the old plan. It is shown that where two or more records are available for the same operation, the more highly skilled workman has a more regular graph and shows less inclination to fall off in his work toward the end of the week. This occurs so frequently that a very irregular graph or serious falling off beginning early in the week will be found, in the great majority of cases, to coincide with a low output.

The experiment on rest pauses consisted of a study of the comparative output and general results from working some double presses with teams of three girls, each operative working for forty minutes in each hour and resting twenty minutes, replacing the old method of employing two girls continuously through the day. The result was that the total increase of output on six presses amounted to more than 44 per cent. — a result obtained with a reduction of the working hours of the individual operative by one-third, and without the addition of new machines. The effect upon the workers was good. At first they were opposed to the new system, but experience reconciled them to it, and none wished to return to the old system. All that were interviewed declared that their health had improved, and that they no longer felt tired out when the day's work was over. The benefit of the new system was felt especially by the weaker and the less highly skilled girls. — G. E. Partridge.

Sickness Frequency among Industrial Employees: Disease Prevalence among Wage-Earners during the First Half of the Year 1920. U. S. Pub. Health Ser., Pub. Health Rep., Dec. 3, 1920, 35, No. 49, 2897–2907. — The work here reported is being done by the Statistical Office of the Public Health Service with the aid of a committee of the American Public Health Association, and includes the collection, tabulation, and publication of information concerning the prevalence of disease among the wage-earning population.

The cases included in the present study are those which caused disability for one week or longer, and the data are obtained from sick-benefit associations. The tables show that the recurrence of the influenza epidemic in the early months of the year has determined the type of the seasonal variation for the whole group of diseases, and that the apex of the curve falls in February. Segregating all diseases except grippe and influenza, there appears to be a steady decline in the frequency rate from the beginning of the year through June when the reports terminate, except for a slight rise during May. The main causes of disability are found in the general, respiratory and digestive diseases. The respiratory diseases show a very large seasonal fluctuation, and are very prevalent as compared with other diseases in the first month of summer. The digestive diseases were the second largest group, the general diseases, in every month except April, being slightly less prevalent. Next to influenza and grippe, the most prevalent diseases were bronchitis, pneumonia, and diseases of the pharynx, principally tonsillitis. Rheumatism occurred more frequently in June than in the winter months, and its incidence rate was fairly high in that month for all the large groups contributing to the materials for the study. In some other respects, however, wide variations were found in the reports from different groups. The frequency rate for two associations for February, for example, stand in the ratio to one another of one to seven, and in April another association shows six times as much sickness as the lower in the two just mentioned. These marked differences are regarded as strong reasons for a careful study not only of the causes of illness in the different plants, but of the conditions which give rise to them.

Co-operation is invited in the collection of sickness statistics. "While the number of reporting associations has been considerably augmented of late, it is hoped that more establishments will report the disabilities occurring among their employees." — G. E. Partridge.

The Typographical Industry in Rome. *A. Ranelletti.* Abstracted as follows from Bollettino Ufficiale Municipale, 1919, in Il Lavoro, Dec. 31, 1920, 11, No. 8, 247. — A. Ranelletti made an investigation of this, the most important industry in Rome. He found conditions good in about half the shops, mediocre in a third, bad in a fifth. Three-quarters of the employees are men, 5 per cent. of them boys from 10 to 15 years of age. The sickness rate is 29 per cent., with many cases of pulmonary tuberculosis. The death rate is high, especially from diseases of the respiratory system and tuberculosis, and the causes are to be found in the early age at which work is begun, the fact that the trade attracts weaklings, and the overcrowded, ill-ventilated printing shops with the danger of lead poisoning. There is a high mortality among the children of printers, especially if the mother is employed in printing. — Alice Hamilton.

Conditions Affecting Health in the Millinery Industry. *S. D. Hubbard* and *Christine R. Kefauver.* Month. Bull. N. Y. City Dept. Health, April, 1920, 10, No. 4, 81–97. — Investigations made by the Division of Industrial Hygiene of the Department of Health revealed almost incredible conditions in the millinery industry. This industry is carried on to a great extent in small shops, many of them located in converted tenements unsuited to the purpose. The industry includes so many different processes, often carried on in different establishments, that it is best to treat it according to its subdivisions, such as artificial flowers, velvets, frame making, feathers (treating, finishing, dyeing), dyeing, assembling, and selling.

In the making of artificial flowers, the conditions are very bad. Gas is used extensively in the processes, and is both a fire hazard and a menace to the health. Wood alcohol, often disguised by artificial coloring, arsenic, and white lead are employed. Irregularity of hours of employment is another evil, and hours are extended by home work, ostensibly taken for other members of the family, but presumably often done by the shop-worker, and not infrequently by very young children.

In velvet working, there is danger from moving machinery, from the presence of more or less continuous moisture and from the use of acids and alkalies in watery solutions under conditions especially favorable for producing irritation of the skin. Ventilation is insufficient, since proper ventilation interferes with the processes. Myositis often results from the work, and those who continue in it for long periods frequently show deposits similar to those observed in rheumatoid arthritis.

The treating of feathers and the making of feather ornaments are difficult to make sanitary under any conditions, but, added to their natural dirty and insanitary hazards, they are very commonly carried on in quarters unfit for any manufacturing purposes, where fire risks are great, lighting poor, and washing facilities negligible. In some of the processes there is danger from chemicals. And yet, despite these very bad conditions, workers were found quite indifferent to them.

A bibliography of twenty titles is appended to the article. — G. E. Partridge.

## INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS: SPECIAL TESTS IN THE SELECTION OF EMPLOYEES

Report on Psychiatry. *Henry R. Stedman* and *Donald J. MacPherson.* Boston Med. and Surg. Jour., Nov. 11, 1920, 183, No. 20, 579–584. — Psychiatry as an aid to industrial efficiency is reviewed. A reasonable application of psychiatry to industry would seem to be the following: (1) physical examination of all applicants for work; (2) mental examination by a period of training and observation, or by mental tests; (3) keeping in personal touch with employees' individual problems by means of good foremen, a system of watching individual efficiency, or a sympathetic staff; (4) training the industrial physician to appreciate human nature in the light of dynamic psychology. — Barnett Cohen.

The Present Attitude of Employees to Industrial Psychology. *Susie S. Brierley.* Abstracted as follows from Brit. Jour. Psychology, March, 1920, 10, pp. 210–227, in Mental Hygiene, Oct., 1920, 4, No. 4, 970–973. — It is difficult to get the "feel" of an original article from an abstract, although in this particular case the reviewer is generous with quotations. Miss Brierley's viewpoint

seems to be broad and sympathetic and she does not neglect details. She gives five reasons for antagonism on the part of the workers to industrial hygiene: (1) suspicion of the motives behind the movement; (2) jealousy for the solidarity of the workers; (3) fear of increased monotony; (4) dread of loss of craftsmanship; (5) emphasis on the value of human personality. It would seem that she omits the usual reaction of the layman to psychiatry — the fear of exposing his failings to a critical analysis and the dread of the stigma of being found to have mental trouble. She does not confine her observation to the worker and his job, but detaches him from his environment and analyzes his psychology as a citizen and a human being. As the British labor unions are more powerful and more ably led than those in this country, the study of the workers' mass psychology should be of particular interest. — Stanley Cobb.

Vocational Selection for Specialized Tasks: A Study of Selective Tests for Hollerith-Machine Operatives. Jour. Applied Psychology, June-Sept., 1920, 4, Nos. 2 and 3, 186–206. — A poor selective process will result in the choice of many candidates who will never make good workers, and from this it follows that money is spent unnecessarily in the trial and error process, that more workers are employed than would be necessary with proper selection, and that the general tone of the working force is lowered, offering fruitful soil for dissatisfaction and unrest. At the present time, there are two evils — the hit-or-miss selective plan, and the patent, or made-overnight "scientific" method, which includes the offers of charlatans who have become very numerous in the field of personnel work.

As a sample of the scientific method applied to the evaluation of tests, the writer offers a comparative study of the results of Civil Service examinations of candidates for Hollerith-machine operatives, and the results of nine psychological tests selected from the Woodworth-Wells series. Correlations of actual ability in the work, as measured by speed and accuracy, with the score in the psychological tests and with the marks obtained in the Civil Service examinations, were computed, and it was found that the correlation of the tests with ability was 50 per cent. greater than the correlation of the commission's marks with ability. — G. E. Partridge.

A New Application of Psychology to Industry. *H. C. Link.* Jour. Applied Psychology, June–Sept., 1920, 4, Nos. 2 and 3, 244–249. — This is a study of a typical industrial problem. The foreman of a group of eighty bullet inspectors said that the rate of pay for the work, done as piece-work, was too low; the time-study man said that the rate was a just one. Investigation of the group by means of the Woodworth-Wells cancellation test and group checking test, which had shown high correlations in previous examinations of inspectors, showed that the bullet inspectors were poorer than any other group of inspectors in the processes tested, and that the trouble was, therefore, probably due to the comparative inferiority of the group rather than to the rate of payment. With this determined, incidental causes of discouragement were looked for. It was found that dissatisfaction and depression were caused by certain regulations in regard to returning for re-inspection work in which mistakes were found. It was discovered that the units subject to return and re-inspection were unnecessarily large, and that the custom of returning all imperfect work to the inspector at the close of the day caused discontent and depression, leaving the inspector with work which must be done the following day without pay. These sources of trouble were easily corrected. Although such problems, the writer maintains, are not psychological problems in the strictest sense, they are broadly psychological, and they constitute an important part of industrial psychology. — G. E. Partridge.

The Place Industrial Medicine Has in a Labor Policy. *Otto Geier.* Factory, Nov. 1, 1920, 25, No. 9, 1416–1417. — The writer calls attention to the fact that many managers lack a carefully defined labor policy although they are unwilling to accept any such policy as outlined by others.

In developing a labor policy it is necessary to have some one who can maintain an intimate contact with the workers. No one is in a better position to accomplish this than the plant physician. His activities should include a much broader field than those of pure medicine. Much of his work should be educational. He should have a broad understanding of the problems of industrial relations, employment procedure, and the safety and sanitary requirements of the plant in which he is employed.

The management should not be satisfied with the doctor who can be hired at a nominal salary. It should place itself in a position to pay adequately and to demand a highly intelligent type of medical service. — C. H. Paull.

Building a Better Force of Workers. *Eugene S. Benge.* Factory, Oct. 15, 1920, 24, No. 8, 1237–1239. — This article is an attempt to show how trade tests may be developed for use in employment departments. There are four general types of trade tests in use at the present time. These are (1) the written test; (2) the performance test which involves the doing of some definite task; (3) the picture test in which the individual is asked to supply something missing in an illustration; and (4) the oral test in which the individual is asked certain questions regarding the occupation involved. In the development of any trade test there are four steps: gathering of trade information; proper stating of questions; standardization by trial upon individuals of known ability; and final revision.

Material for trade tests can be best obtained from men actually at work in the trade. Where pictures are required illustrations from technical or similar journals are often helpful.

In the standardization of tests those adopted for final use should be proved to apply to the particular class of workmen for whom they are intended. The writer gives a chart for expressing visually the values of various tests as applied to types of workers. — C. H. Paull.

## INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Courts and the Accomplishment of Workers' Safety. *Schilling.* Zentralbl. f. Gewerbehyg., Dec., 1920, 8, No. 12, 225–228. There is a certain amount of complaint at the failure to impose suitable penalties for violations of the rules for industrial safety. The lack of co-operation of the industrial inspectors and the prosecuting attorneys is believed to be partly responsible. The proper observance of the existing laws and rules of practice by these officials would help. Some suggested new rules of procedure for prosecution of cases and the carrying out of sentences are given. — E. L. Sevringhaus.

Objectives and Results in Legislation for the Protection of Workers. *Koelsch.* Abstracted as follows from Deutsch. med. Wchnschr., 1919, Vol. 45, 347–349 by Globig in Hyg. Rundschau, May 1, 1920, 30, No. 9, 283–284. — "Of the demands of the Erfurt program for the year 1891 the author mentions as obtained the eight-hour normal working day, the unbroken rest period of thirty-six hours in each week, and the forbidding of the payment in goods rather than money, the truck system. The age limit for industrial child labor remains still at 13, not at 14 as demanded. The forbidding of night work extends at present only to women and children and to bakeries. Of the further demand for a supervision of all industrial pursuits, up to the present time the mercantile and commercial pursuits are excluded. In the discussion of the demand of the Erfurt program for a thorough industrial hygiene the author describes the present expansion of the industrial medical service and its future. For the training of industrial physicians he desires more contact with practical life, continuation courses, etc." — E. L. Sevringhaus.

Regulations of Jan. 27, 1920 of the Imperial Minister of Labor for the Establishment and Management of Works for the Preparation of Lead Colors and Other Lead Compounds. Abstracted as follows from Reichs-Gesetzbl., p. 109, by *G.* in Hyg. Rundschau, March 15, 1920, 30, No. 6, 187–188. — "According to No. 11 of the Regulations the employer must forewarn employees who will come into contact with lead-containing substances as to the deleterious effects of lead on health and the conduct required while in contact with such materials. He must give them the notice published by the imperial minister of labor.

"The above-mentioned Lead Notice, printed in the *Veröff. d. Reichs-Ges.-A.*, 1920, No. 7, p. 127, is as follows:

" 'Every one is liable to the danger of lead poisoning who in the course of his work comes into contact with lead or lead compounds (except lead sulphide), or other lead-containing substances. This danger is the greater since this poison (excepting sugar of lead) does not reveal its presence to the worker by either

smell or taste, thereby warning him before it is taken into the body. Lead poisoning usually occurs in this wise: Lead which has remained clinging to the hands, clothing or beard gets into the mouth in small amounts during eating, drinking, or the smoking, snuffing or chewing of tobacco, or the dust is breathed during work. The lead accumulates slowly in the body and brings on the poisoning sooner or later, according to the amount of the poison absorbed and to the resistance of the worker. If a blue-gray border (lead-line) appears on the gums near the edge of the teeth, this is an indication that an appreciable amount of lead has already been taken into the body and that an attack of lead poisoning threatens to occur. The existence of a lead-line should cause the worker to be more careful than before to see that he takes in no more lead; he still has it in his power to escape an attack. Otherwise there will occur often very soon, at times however only after weeks or months, the real lead poisoning which is truly painful, lingering, and under certain circumstances dangerous to life.

"'*Prevention of Lead Sickness.* — Lead poisoning can be avoided with certainty by care and cleanliness. Especially are the following points to be observed: (1) As far as possible during work the hands and working clothes are to be guarded against soiling with lead, lead compounds or lead-containing substances. The nails should be kept closely cut. During work smoking, snuffing, or chewing tobacco is to be omitted. Cigars, tobacco, pipes and other smoking articles shall not be carried into the working rooms. (2) Workers may not eat, drink, or leave the place of work until they have first taken off their working clothes and thoroughly washed their hands with soap and brushes. The face and especially the beard deserve a careful cleansing if they have become soiled during the work. (3) In all lead work the above mentioned work clothes are to be worn. To avoid the breathing in of lead-containing dust, in all work where dust is formed, if the dust is not completely and immediately carried off by suction, respirators, damp sponges or muslin bands, which cover nose and mouth, are to be worn. (4) The widely accepted belief that the regular use of certain drugs (potassium iodide, sulphur pills, Glauber's salt and other cathartics) or the drinking of milk is sufficient protection against lead poisoning is not justified. On the other hand a certain value is to be attributed to a strong and well nourished condition and therefore also to the drinking of milk. The use of alcoholic drinks, especially of brandy, increases the danger of an attack of lead poisoning and is therefore to be shunned. (5) Exercise in the open air, gymnasium, baths, etc., make the body more resistant and should therefore be made use of as much as possible. If a worker who comes into contact with lead, lead compounds, or lead-containing substances is taken sick, in the interest of himself and his family he should at once consult a physician and tell him immediately that he comes in contact with lead in his work.'

"In No. 17 of the 'Regulations' it is provided that the investigation and supervision of the condition of health of lead workers is to be assigned to a physician approved and empowered for the purpose by the higher government board. This authorization is to be conferred only after the physician has taken oath to follow a certain course of service as prescribed by the imperial minister of labor. This course of service is described in the same place referred to above, p. 127. It contains in an appendix a guide to special methods of study for the confirmation of a case of lead poisoning: (1) hemoglobin determination; (2) search in the blood for stippled erythrocytes; (3) blood pressure determination; (4) search in the urine for hematoporphyrin." — E. L. Sevringhaus.

French Court Decisions Regarding Incapacities from Industrial Accidents. Abstracted as follows from Jour. Société de Statistique de Paris, June, 1920, in Month. Labor Rev., Sept., 1920, 11, No. 3, 162. — "The French industrial accident law of April 9, 1898, provides that a totally and permanently injured person shall receive compensation equal to two-thirds of such person's yearly earnings, but the law does not indicate what constitutes a total permanent injury nor does it establish any basis for computing the industrial incapacity resulting from various lesions.

"During the twenty years the law has been in operation the decisions of the courts, though not invariably settling these important questions, serve as a criterion.

"The burden of the proof is on the injured person; the judges must estimate the effect of the injury on normal industrial capacity. Compensation is invariably based on the earnings of the injured at the time of the accident. The probabilities of future increase in earnings and aggravated injuries, due to the act of the in-

jured, have not been considered. Total incapacity is understood as rendering the injured person incapable not only of performing his usual work but also any other remunerative labor. . . . Permanent infirmity resulting from slow and prolonged development due to normal and continued labor not compensable." The determination of the amount of compensation depends upon the effect of the injury on the injured person's industrial capacity. — M. Dent.

A Plea for More Adequate Compensation Rates. *E. Stewart.* U. S. Bur. Labor Statis., Month. Labor Rev., Dec., 1920, 11, No. 6, 1–8. — It is probably generally admitted that compensation, even under the conditions prevailing at the time when the laws were passed, has never been adequate. But now conditions are much worse. Even in the most liberal states the workman receives a much smaller percentage of his wages as compensation, and the total cost of compensation for the employer is a very much smaller percentage of the payroll than in 1916. The trouble is caused by the waiting time and by the provision for maximum compensation.

The writer's main point is that "if it is agreed that the statutory percentage is a fair division of the burden as between the employer and the employee, then the question of the justice of removing the complications caused by the weekly minimum is one that it would seem might be fair to consider." To show how the present regulations work, tables are presented indicating, for the states providing compensation, the relation of the statutory weekly compensation to the standard wages received by specified occupations; the actual percentages of wages received as compensation, for 1920, by specified occupations; the actual percentages of wages received as compensation by structural iron workers for specified years; and other useful computations bearing on the case.

The following statements are typical: Connecticut, which apparently in 1920 paid a man earning $40 per week 35 per cent. of his wages if injured, owing to her seventeen day waiting period did in fact pay him but 31.7 per cent.; and in the case of Delaware, where a fourteen day waiting period obtains, instead of an apparent 37.5 per cent. we find an actual 29.7 per cent. — G. E. Partridge.

Systems of Medical Service. *John W. Mowell.* Mod. Med., Dec., 1920, 2, No. 12, 802. — The present Medical Aid Act of the state of Washington was passed in 1917 as an amendment to the Workmen's Compensation Act, found to be absolutely necessary for the provision of efficient treatment for injured workmen. The separate board which administers the amendment has provided two systems: (1) the "Contract System," whereby "an employer may, with the consent of 51 per cent. of his employees, enter into a contract with a physician or hospital for the care of his injured workmen, this contract to be approved by the Medical Aid Board and the contractor to receive 90 per cent. of the money contributed from such employer and his employees for medical aid as payment for this service;" and (2) the "State's Plan" whereby "all employers who see fit not to contract pay all of the medical aid money into the medical aid fund, out of which all surgical, hospital and other bills for injured workmen are paid," and the employee is given free choice of physician and hospital in the first instance. The Medical Aid Act provides that a physician and surgeon shall be chairman of the board, and delegates to him, with the approval of the board, the administration of rules and regulations, thus enabling the board to consider efficiency of treatment only; for instance, while the man has the choice of his physician in the first instance, the board can, if it thinks best, move a patient who is seriously injured to another locality where he can receive the best possible treatment for his particular injury. This provision allows the board to take up reconstructive or post-operative work and is the greatest feature of the Medical Aid Act in Washington at present. — Elizabeth C. Putnam.

Medical Service under the Massachusetts Workmen's Compensation Act. *Francis D. Donoghue.* Mod. Med., Dec., 1920, 2, No. 12, 803–805. — "From a modest beginning, the medical work of the Massachusetts Industrial Accident Board has greatly developed until its importance is now second to no other provision of the law, not excepting even compensation provisions. From a little section dealing with the furnishing of medical and hospital services during the first two weeks after the injury only, the law has been amended until it now takes in every case of serious and unusual injury, provides for reasonable medical and hospital treatment and medicines for the full period of hospital care, under the wise and

broad interpretation given the 'unusual case' provision of the law by the Board, and lately has been amended so that the Board may, whenever in its opinion such appurtenances are beneficial, order the insurer to furnish and pay for artificial appliances and thus get the employee back into industry within the shortest possible period of time." The medical features of the law have been given a place among the most important sections of the statute, and have been amended to provide that hospital records, duly certified, and the written report of the "impartial physician" shall be admitted as evidence before the Board.

The work of the Medical Department, established in 1914, embraces the systematization of the vast amount of medical information required under the Workmen's Compensation Act; advice with reference to all medical problems; the outlining of the fundamental medical facts required to decide whether disputed cases are covered by law; and "the preparation of such cases impartially for hearing, in order that provisions of the Act may be made effective speedily and with the least possible cost and annoyance to the parties at interest." It further includes the selection and supervision of the "impartial examining physicians." They are chosen, if possible, from a locality near the employees' home, but in some cases it becomes necessary for patients to report for examination to Boston or some other large center. "In all cases the aim in selecting physicians is to provide the man whose training and experience fit him to examine and report expertly, according to the special features involved in the case, not only as to the past disability but as to future treatment. When the impartial report is received at the medical advisor's office, the case is first read by him to make sure the report covers the necessary points. Copies are then sent to the employees, insurance companies, and perhaps to other persons directly interested, so that everyone has a medical opinion which under the law has the weight of being entirely separated from any direct interest in behalf either of the employee or of the insurance company. The impartial physician has eliminated the professional witness who appeared in court for or against the claimant. It was found that in Massachusetts malingering was almost unknown and that what was needed from the specialist was his aid in restoring function rather than in determining whether or not the disability existed. "The great success of the Accident Board has come from the utilization of the best medical brains in the commonwealth." The medical advisor's office gives informal opinions in insured fatal cases; in cases where additional compensation for permanent disabilities is in question; and in instances of disputed bills. Many questions are thus settled informally, although neither side is thereby prevented from having a formal hearing and decision.

One of the difficulties that the Industrial Accident Board faces, and one which will eventually be eliminated by a more careful checking up of practitioners and hospitals by the Massachusetts Board of Registration in Medicine or some other state board, is the decision in cases where the employee has chosen his own doctor or hospital and has chosen unwisely. But under present conditions, "outside of a law providing specifically for complete medical and hospital care for the full period of incapacity, the Massachusetts law, as interpreted by the members of the Industrial Accident Board, could not be improved upon." — Elizabeth C. Putnam.

Workmen's Compensation, with Especial Reference to Loss of Vision. *Frank Allport.* Jour. Am. Med. Assn., Jan. 17, 1920, 74, No. 3, 166–168. — The writer calls attention to the possibility of considerable injustice being done to employers in awarding compensation in cases of eye injury. Lack of properly established standards for measuring impairment of vision leads not infrequently to damages being allowed beyond the extent of the injury. Except in the case of monocular traumatic cataracts, compensation should be based upon visual results obtained with glasses rather than upon results obtained without glasses.

It is pointed out that laws are unjust both to the worker and to the employer where they make the employer responsible for the loss of both eyes when one had been lost at a time previous to employment. Such laws put an undue burden upon the employer and at the same time make the procuring of work more difficult for individuals possessing a visual handicap.

In constructing a table for monocular visual losses which might well serve as a common standard, the writer points out that three points must be considered:

1. "What constitutes industrial blindness in one eye?

2. "What is the maximum legal compensation for such blindness?

3. "What are fair and diminishing percentages of visual losses from maximum to minimum?"

Taking the standard of the Chicago Ophthalmological Society as being fair, the writer concludes that vision worse than 20/200 constitutes industrial blindness. The answer to the second question is at present determined by state laws. In Illinois the maximum for monocular blindness is $1200.

The answer to the third question is worked out in a table given on page 168. Varying percentages of visual efficiency are given from 20/20 to 20/200, the range of percentages being 100 to 10 per cent. — C. H. Paull.

Your Liability for Concurrent Compensation. *Chesla C. Sherlock.* Am. Machinist, Nov. 25, 1920, 53, No. 22, 998–1000. — This article explains the amount of compensation allowable for various degrees of injury resulting from the same accident. Court decisions of several states are given as examples. — G. M. Fair.

Corrections versus Compensation of Physical Defects. *R. I. Lee* and *L. T. Brown.* Abstracted as follows from Am. Jour. Med. Sc., Nov., 1920, 110, No. 5, 651 in Jour. Am. Med. Assn., Jan. 22, 1921, 76, No. 4, 268. — "Lee and Brown are not prepared to support the theory that many ailments of the nervous system or of the gastro-intestinal system are related to bad mechanical use of the body. However, they state that there is a frequent association of such symptoms with the mechanical use of the body. Their investigations have shown that albuminuria of young men which is not a true nephritis is associated almost exclusively with very bad mechanical use of the body. They believe that a sufficient case can be made out of correction as against compensation on the basis of actual ailments of the back and feet, generally conceded to be due to faulty use of the body even without the addition of possible symptoms connected with other organs. Physical training can only accomplish what it is expected to accomplish when it is based on satisfactory fundamental principles and when bodily mechanics is regarded in a similar fashion as are the disturbances of any other system of the body." — M. C. Shorley.

British National Health Insurance Act of May 20, 1920. *H. J. Harris.* U. S. Bur. Labor Statis., Month. Labor Rev., Sept., 1920, 11, No. 3, 1–11. — In this article the author points out a number of important changes made by this act "in the health insurance system described in the Monthly Labor Review for January, 1920. Pages 45–59." — R. B. Crain.

Obligatory Sickness Insurance. *Borne.* Revue d'Hygiène, April, 1920, 42, No. 4, 252–284. — There are presented in detail the legal provisions in Switzerland, England, Belgium, Germany, Austria, and France for including certain specific occupational diseases with industrial accidents for which compensation to affected workmen must be paid. The author endeavors to make clear that it is impossible to provide adequately by such means for compensation due affected workmen through disability which may unquestionably develop because of conditions of employment, because in many instances the disability cannot be demonstrated with necessary exactness to be due to conditions of employment. He believes that only with compulsory health insurance can these doubtful cases receive the proper compensation, and presents briefly a proposed law already brought before the Chamber. — Wade Wright.

## REHABILITATION OF DISABLED EMPLOYEES

Vocational Rehabilitation of Persons Disabled in Industry or Otherwise. Voc. Summary, Aug., 1920, 3, No. 4, 49–51. — An act passed by Congress and approved by the President on June 2, 1920 provides for the promotion of vocational rehabilitation of persons disabled in industry or otherwise, and their return to civil employment. It is very difficult to obtain even an approximate estimate of the number of such cases occurring annually in the United States, but the number is probably not less than 100,000, and 200,000 may not be too high an estimate. The annual yield does not, of course, indicate the total number of cases accumulated already, and perhaps 600,000 are now living who are more or less handicapped

because of industrial accidents; to this must be added the great number of injured persons not properly classified as belonging to the industrially injured.

As a contribution to the support of the program of rehabilitation, Congress has appropriated $750,000 for the year 1920–1921, and $100,000 a year for the three following years. To benefit under the act the several states must match this expenditure, and acceptance of the federal act by any state makes the state responsible for the maintenance and supervision of such rehabilitation courses as may be provided out of the joint federal and state fund. The states will be obliged to maintain organizations capable of performing such services as keeping a list of persons eligible to rehabilitation aid, imparting accurate information to prospective beneficiaries, determining eligibility for rehabilitation and training, systematic personal advisement of these prospective beneficiaries, and, in the case of those who accept training, continuous advisement and supervision during the whole period of training and placement. Co-ordination can advantageously be arranged with state boards for vocational education and other state agencies, and this is especially true of the agency in every state which has charge of the administration of the workmen's compensation act. The first and greatest need is publicity; this will be the best basis for the individual case work that is to come. — G. E. Partridge.

Bill Proposed for Co-operation by all States under the New Federal Law for the Rehabilitation of Industrial Cripples. *Frederick MacKenzie.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 246–249. — On June 2, 1920, "an act to provide for the promotion of vocational rehabilitation of persons disabled in industry or otherwise and their return to civil employment" was passed by Congress. The act authorizes the federal board to allot certain sums to the states, "in proportion to population, on condition that each state appropriate an equal amount for vocational rehabilitation." To qualify for this allotment and "bring to complete success this enlightened development of workmen's compensation . . . each state must accept this act, empower its state board for vocational education to co-operate with the federal board, arrange for co-operation between its state board and its workmen's compensation commission, provide for courses of vocational rehabilitation and appoint the state treasurer as custodian of funds. Each state board for vocational rehabilitation must submit its plans to the federal board for approval, open its courses to disabled federal employees and report annually." Five states (New York, Georgia, New Jersey, Nevada and North Carolina) have already accepted the provisions of this act. In addition nine states (California, Illinois, Massachusetts, Minnesota, Nevada, New York, Pennsylvania, Rhode Island, and Virginia) have taken advanced steps for rehabilitation of industrial cripples, although they have not specifically accepted the federal law. Through a special provision allowing the governor of the state to accept the plan temporarily in case his legislature did not meet before Dec. 31, 1920, it is now in force in twenty states (Alabama, Arizona, Arkansas Delaware, Indiana, Idaho, Iowa, Michigan, Minnesota, Mississippi, Nebraska, New Mexico, North Dakota, Ohio, Oregon, South Carolina, Tennessee, Texas, and West Virginia).

"The present urgent need is the passage of a bill by every state to make possible at once full co-operation with the national government." The complete text of a tentative draft of such a bill, prepared by the American Association for Labor Legislation and the Federal Board for Vocational Education, is given in this article as an aid to prompt legislative action. — Elizabeth C. Putnam.

Rehabilitation of the Tuberculous in District 12. *L. W. Bartlett.* Voc. Summary, Nov., 1920, 3, No. 7, 101–102. — An account of the vocational training of tuberculous patients through the Federal Board in District 12. A training in vocational and general subjects is given while still in the hospital. The factors involved in this training are: (1) the selection of a training center; and (2) close and constant supervision. The most difficult problem in rehabilitating the tuberculous is the actual employment, which must always be accompanied by the strain of competition. Finally the author points out that vocational training in the convalescent stage occupies the mind and speeds recovery; that proper training converts the trainee into a self-sustaining citizen; and that the welfare of the tuberculous is of national concern, demanding hospital care, vocational training and employment. — L. A. Shaw.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

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## CONTENTS



## GENERAL

RELATION OF INDUSTRIAL MEDICINE TO PUBLIC HEALTH. *R. T. Legge.* Am. Jour. Pub. Health, Jan., 1921, 11, No. 1, 62–64. — The degenerative diseases are the cause of much unnecessary illness and early demise, and, in so far as many of these conditions are the result of labor, with its industrial fatigue and strain, and the environmental surroundings of the worker, it behooves the public health official to interest himself in industrial hygiene. The modern industrial physician must be not only an epidemiologist but a hygienist. While the work of large plants may be cared for by their own industrial physicians yet there are many smaller plants, labor camps, and mines without proper health supervision, making a "no man's land" which should be cared for by bureaus of industrial hygiene in federal, state and municipal boards of health in charge of specially trained experts. The public health profession has not adequately met its responsibilities unless this is generally recognized and provided for. — H. F. Smyth.

THE FUTURE OF INDUSTRIAL MEDICINE AS A LABOR POLICY. *Otto P. Geier.* Mod. Med., Dec., 1920, 2, No. 12, 794–796. — Looming large in the universal unrest and disorder which are shaking all nations as never before, is an industrial strife of proportions beyond imagination. Not only is the industrial output fatally low at the very moment when mass production is most needed, but the disorganized character of industrial life pulsating throughout the community makes for an unhappy, restricted existence and for bad citizenship.

In no phase of the world's disorder is it more true than in industry that peace and progress will not come from the old-time policies and diplomacies, but from individual right thinking and doing. The old labor policy, which too often consisted only in a blind prejudice against organized labor and was more properly a lack of labor policy, is helpless in meeting the present conditions. A new policy — a thoughtful conclusion based on all the basic principles of social and economic justice that enter into wage con-

ditions, necessarily tempered by the varying attitudes of the employer and employees — must be formed. Recognizing that while much may be learned through broad reading and from the practical results of other researchers after similar truths, the greatest wisdom will be gained through genuine, human relations between management and workmen, many leaders in industry are establishing personal service, or "human relations" departments. Here is the great opportunity for the industrial physician. All better understanding is most successfully based upon the better physical and mental health of individual workers; and, furthermore, the relation between physician and patient is that most desired in personal service departments — simple, direct and natural, with no suggestion of paternalism. Thousands of contacts are made each year through the medical department; and the physician who has the support of the management, a knowledge of the safety and sanitary requirements of the plant, and a broad understanding of the problems of industrial relations, has it in his power to make a marked contribution toward the solution of industrial difficulties and thus of the world-wide disorganization of today. — Elizabeth C. Putnam.

Types of Physicians Contracting with Industry. *Otto P. Geier. Ed.* Mod. Med., Dec., 1920, 2, No. 12, 793. — In the discussion of a recent committee report concerning industrial medicine as a specialty made to the Cincinnati Academy of Medicine, the definition, scope and results of industrial medicine were brought up as preliminary to a consideration of the types of industrial medical practitioners. Industrial medicine embraces not only the care of injured and sick employees as the need may arise, but the securing of clean working conditions, of state compensation and sickness insurance, the mechanical safeguarding of machinery, physical examination at the time of employment and later, and the education of the worker in safe mechanical processes, in hygiene, in the avoidance of quacks and the wide use of the physician and dentist for himself and his family. The true industrial physician, therefore, is not one who, in the course of private practice, cares for the victims of industrial accident; is not one who gives a certain time to work within the plant while keeping his chief interests outside; is not even one who agrees to give some supervision to the sanitation of several factories and to give medical or surgical attention when asked. He is, rather, one who gives up private practice to enter industry for the purpose of using his knowledge of medicine, surgery, hygiene, safety, economics and psychology to serve the worker and the management. He will bring all his specialized science to bear upon unhealthy *working* and living conditions, and unhealthy attitudes of mind toward the job and society, and will thereby increase individual and community health, wealth, and happiness. — Elizabeth C. Putnam.

Welfare in Factories and Workshops. *A. M. Anderson.* Great Britain Ann. Rep. Chief Inspect. Factories and Workshops for the Year 1919, 73–82. — Rules were made in 1919 for examining fruit preserving works, oil cake mills, laundries, gut scraping, manufacture of hollow ware, galvanizing, and herring pickling works. Inspectors report good progress in securing legally or voluntarily improved conditions.

Voluntary messrooms, canteens, lavatories, cloakrooms, and lunchrooms were found in many factories in Sheffield; such, over the kingdom, "get the pick of the labour in the neighbourhood." In practically all new factories most of these things are provided for, but in older factories where room is scarcely available progress must be slow unless compulsion is brought to bear. Slowness in these things is greater in cotton than in woolen manufactures. In the Lancashire and Yorkshire districts and in the metal industries in the Midlands, "there is, with one or two exceptions, practically no welfare work." In glass works, bichromate, fruit preserving, and oil cake works, requirements are well in progress.

*Drinking Water.* — Here the order of 1917 is giving the results anticipated.

*Canteen and Messroom.* — Advance is tardy in this branch of welfare work but there are many exceptions. Canteen service is best in engineering, wire making, iron founding, gas works, india rubber works and woolen mills. Messroom service is best in paper making, box and stationery, drugs and ink making, brewing and beer bottling, job dyeing and rag sorting, and excellent development appears in clothing factories in the Northwest Division and North London. "Since the institution of this canteen, fainting attacks which used to vary from two to ten a day have fallen to about one a week." A separate canteen is maintained for men. Con-

ditions are as yet less favorable in many workshops in London and in city factories. In Ireland progressive firms are arranging messrooms and the spirit is encouraging.

*Protective Clothing, Conveniences.* — Regulations require protective clothing when material such as potassium bichromate is handled, or when the work itself is hot or dirty.

In Scotland the requirements of the welfare order in regard to women are being carried out, especially in glass works. In fruit preserving and laundries advance is variable but progressive.

*Seats.* — Seats are supplied by various prosperous industries and are found to conserve the powers of the employees. In the Northeast Division nearly everyone in a cotton spinning mill had a comfortable seat and the women could watch their machines better when seated. In Yorkshire and Lancashire a majority of mills had no seats.

*Volunteer Welfare in Shale Oil Works.* — Rules have been observed in Scottish shale works during the past year protecting workmen from spent shale dust and fumes; for shelters, protective clothing and spray baths; periodical medical examination, first aid and ambulance, and special treatment of skin affections, with gratifying results. Masks are provided when the atmosphere is poisonous.

*Welfare in the Fish Curing Industry.* — The special hardship of this work engaged the attention of welfare workers for many years before the war. This seasonal trade is carried on by women in October and November on the beaches in sheds with three sides open to the weather. Housing was inadequate and many workers, after hours of standing at the farlanes, had long distances to go for lodgings and food. Many suffered from salt sores, due to salt entering the cuts made by knives in gutting fish. The inspectors all reported need for mess and rest rooms, first-aid stations, cloak and washrooms. The worst conditions were at Yarmouth and at Lowestoft. — F. Fremont-Smith.

THE LONG DAY: DOES IT PAY? *Ed.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 264–272. The considerations of leisure for citizenship, for recreation, and for home life and protection against strain should be the fundamentals for determining hours of labor. Long hours, though popularly supposed to be eliminated, are still very real in the steel industry.

The three conventional objections urged against the shorter shift are: (1) The company cannot afford it. As a matter of fact, it has been proved invariably true that, when the transfer has been made thoughtfully and scientifically, it not only does not cost more, but it actually pays. (2) The men do not want it. This is true if it means cut wages, but experience proves that wages are not decreased but often increased because of the increased efficiency of the worker. (3) It will open wider the door to foreign competition. The contrary is true because the efficiency of the highly paid, scientifically trained American workman is so much greater that "fear of foreign competition has been reduced or even cut out entirely in this country in factories under a careful reorganization, a feature of which was the shorter shift." — Elizabeth C. Putnam.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

ELECTROCARDIOGRAPHIC STUDIES IN ACUTE POISONINGS. *E. Schott.* Arch. f. exper. Path. u. Pharmakol., Sept. 24, 1920, 87, No. 5, 21. — The author gives the graphic records and protocols of a number of experiments upon frogs, guinea-pigs, and rabbits, given large doses of various poisons, sodium salicylate, benzol, tetrachlormethane, ethyl chloride, chloroform, ether and alcohol. These substances, which are of course encountered in many technical processes, each produce a more or less characteristic alteration in the form of the electrocardiogram, which Schott believes might be of diagnostic value clinically. — T. J. Putnam.

TOXIC EFFECTS OF CARBON MONOXID. *W. H. Wilmer.* Am. Jour. Ophth., Feb., 1921, 4, No. 2, 73–90. — The bulk of this article is devoted to a description of the experiences of a family in a "haunted house." The odor of gas was often noticed and on investigation a leaky furnace was found. The symptoms, chiefly auditory and visual hallucinations, were attributed to carbon monoxide intoxication. A case

of optic neuritis, found in a member of this family four years after leaving the house, was considered by the writer to be due to carbon monoxide poisoning. — H. S. Forbes.

Asphyxiation in Garages. N. Y. Dept. Labor, Special Bull. No. 101, Dec., 1920, pp. 23. — This report is based chiefly on an inspection of 1,308 garages and auto-repair shops in New York State. One hundred and thirteen cases of asphyxiation (degree not stated) were found within two years. All but twelve of these occurred outside of New York City, indicating the greater danger in smaller garages where men may be working singly.

The concentration of carbon monoxide, the chief poisonous constituent of exhaust gas, is given as 0.05 per cent. to cause headache, and 0.2 per cent. to be very dangerous. These figures are quoted from Haldane. In considering the question of chronic exhaust gas poisoning no mention is made of benzol being a possible important factor. Better garage ventilation is urged. Only thirty-six garages of the 1,308 had the better type of ventilation by tube from the exhaust pipe heading directly out of doors. — H. S. Forbes.

The Spinal Fluid in Carbon Monoxide Poisoning. *Legry* and *Lermoyez*. Abstracted as follows from Presse méd., Nov. 13, 1920, 28, p. 816, in Il Lavoro, Dec. 31, 1920, 11, No. 8, 238. — Lumbar puncture made under certain conditions affords a valuable aid in the diagnosis of carbon monoxide poisoning. The fluid comes out under increased pressure, is clear, with a slight sediment of red blood cells and of leukocytes, two-thirds of which are polynuclears and one-third mononuclears. This cytologic meningeal reaction is to be attributed to a congestive and hemorrhagic process in the cortex. — Alice Hamilton.

Extensive Intravital Clotting in Illuminating-Gas Poisoning. *E. Hedinger*. Vrtljschr. f. gerichtl. Med., April, 1920, 59, series 3, No. 2, 177–181. — In cleaning a plugged pipe at a gas plant, a 45-year old workman was forced to breathe an unusual amount of illuminating gas, so that in the afternoon he complained of a queer taste in his mouth and had no appetite. At 3 o'clock the next morning he awoke and complained of nausea, and fell flat on the floor when he got out of bed. He managed to get back to bed again, however. About three hours later he had a free movement of the bowels and felt better, but soon after he suddenly fell dead.

The autopsy was held at 4 p.m., with the following results:

*Macroscopic Findings.* — Well-marked death rigor; skin a striking bright red; no edema; extreme varicosity of both long saphenous veins, especially above the knees; heart large and flabby (weight, 370 gm.). In the right heart a large dark red clot with a dull surface, which was continued into the chief branch of the pulmonary artery. The same kind of clot was found in the small lung arteries, the inferior vena cava, and both interior and exterior common iliacs. The femoral veins and the varicose saphenous veins were full of bright red blood; the lungs were very hyperemic, and scattered throughout them were dark red wedge-shaped thrombi, measuring 1 to 3 cm. The pleura was smooth and shining over these spots. The brain and other organs showed simple hyperemia. Carbon monoxide was present in the blood.

*Microscopic Findings.* — In the region of the lung infarcts there was extensive invasion of the meshwork with crenated red blood corpuscles. The alveolar septa and epithelium still showed good nuclear staining. The vessels nearby were packed full of red blood corpuscles, with some fibrin and white blood corpuscles. The large thrombi in the lung arteries and in the inferior vena cava consisted almost entirely of many red blood corpuscles with a little fibrin, suggesting a postmortem clot. The long saphenous vein showed thickening of the intima in spots, with a rather sharp interruption of the elastic intima, but without infiltration. The other organs showed simple hyperemia.

It is well known that small thrombi can be formed in carbon monoxide poisoning, although in acute illuminating gas poisoning the bright red blood is usually fluid for a long time. In this case the author thinks that the extensive clotting can be accounted for by the predisposing condition which was present in the varicose veins. The small amount of thrombosis present was tremendously accelerated by the carbon monoxide, so that large enough emboli were sent off to cause death. — H. G. Noyes.

Acute Poisoning from Nitrous Fumes. *F. Jacoulet*. Abstracted as follows from Paris méd., Nov. 20, 1920, 10, No. 47, 369, in Jour. Am. Med. Assn., Jan. 8, 1921, 76, No. 2, 144. — "The plumber had been repairing a ventilator opening into the 'lead rooms' of a chemical

fertilizer factory, and was exposed to the nitrous fumes for several minutes. He felt a general malaise during the afternoon, and at night developed a distressing spasmodic cough. By the next morning the dyspnea was extreme, all the symptoms suggesting suffocating capillary bronchitis. Wet cups were applied and spartein and camphorated oil injected without relief. Venesection improved conditions a little but the condition grew progressively worse, with subcoma, progressive asphyxia and asystoly, the condition desperate by the thirty-sixth hour. Then subcutaneous injection of oxygen through a serum needle induced slight progressive improvement. In forty-eight hours more than 80 liters of oxygen were thus injected, forming an emphysema over the entire body to the base of the chest, and the man rapidly recovered. In Pic and Durand's case the man was in complete coma but recovered after subcutaneous injection of 180 liters of oxygen the first day, to a total of 230 liters in forty-eight hours. The diffusion and absorption of the oxygen are promoted by light massage; the absorption proceeds the more rapidly the more avid the tissues for oxygen. Jacoulet knows of only four attempts to inject oxygen by the vein, and urges that for the present it is better to keep to the subcutaneous route. This has proved its harmlessness, and these cases demonstrate its efficacy." — M. C. Shorley.

Perforations of the Nasal Septum Due to Inhalation of Arsenous Oxid. *L. G. Dunlap.* Jour. Am. Med. Assn., Feb. 26, 1921, 76, No. 9, 568. — The author concludes with the following summary:

"1. Arsenous oxid is a valuable by-product of the Rocky Mountain copper ore smelting, and many workers come into contact with tons of the pure product.

"2. Arsenous oxid causes a characteristic septal perforation and associated pathologic condition of the skin, throat and eyes.

"3. Treatment consists of: (*a*) resection of cartilage, producing mucosa to mucosa approximation, or, in smaller perforations, (*b*) plastic operation or (*c*) a mechanical obturator to relieve the objectionable crusting." — C. K. Drinker.

Question of the Resistance of Various Animals to Arsenic. *M. Willberg.* Abstracted as follows from Sitzb. Naturf. Ges. Univ. Dorpat., 1919, 22, 42–88; Zentr. Biochem. Biophys., 21, 288, by H. S. Paine in Chem. Abstr., Dec. 10, 1920, 14, No. 23, 3724–3725. — "Large doses of $As_2O_3$, when administered *per os* to dogs, caused vomiting with consequent elimination of the greater part of the poison. Dogs showed equal resistance to subcutaneous and internal administration of $K_3AsO_3$; doses exceeding 0.007 gm. per kilogram of body weight caused death. Extensive necrosis of the subcutaneous tissue and skin around the site of injection was invariably observed when $K_3AsO_3$ was subcutaneously injected. The skin of the dog showed pronounced sensitiveness to As as compared with the skin of other experimental animals; the skin of cats showed similar sensitiveness. The limiting dose of $K_3AsO_3$ for rabbits was 0.009–0.01 gm.; 0.016 gm. of $As_2O_3$ caused death. In general, when administered in double amount, $As_2O_3$ killed them only about half as rapidly as $K_3AsO_3$. $As_2O_3$ is capable of causing miscarriage. Hares showed less resistance than rabbits to subcutaneous injection of $K_3AsO_3$. Of all mammals studied, mice showed the greatest relative resistance to subcutaneous injection of $K_3AsO_3$. Guinea pigs easily withstood repeated subcutaneous injection of $K_3AsO_3$ in doses of 0.003–0.009 gm. per kilogram; a single dose of 0.01–0.012 gm. caused death. Hens showed varying behavior, but all succumbed with gastroenteritis when 0.06–0.15 gm. of $As_2O_3$ was administered *per os*; melanosis of the comb always occurred. Pigeons tolerated 1.786 gm. of $As_2O_3$ per kilogram of body weight, inasmuch as the poison was eliminated by vomiting; they were sensitive to subcutaneous injection of $K_3AsO_3$. In the case of snakes, administration of 0.019 gm. per kilogram caused death.

Is the Industrial Disease of Briquette Makers Chronic Arsenical Poisoning? *Burkhardt.* Zentralbl. f. Gewerbehyg., Dec., 1920, 8, No. 12, 220. — This is a criticism and refutation of the article by Bayet and Slosse which was abstracted in this Journal, 1919, Vol. 1, p. 66. The Belgian authors maintain that the skin lesions of briquette workers are caused by the presence of arsenic in the coal used for briquette manufacture, and back up their assertion by presenting analyses of coal, coal dust, hair, blood, and urine of workmen, all positive for arsenic. They also insist that all workmen engaged in industries which work up anthracite coal or its by-products are exposed to arsenical poisoning, for they claim to have

found it in the dust in illuminating gas plants, in the tar and purification residue of the same plants, and finally in the hair and blood of the workmen.

Burkhardt believes that publications of this kind are likely to cause widespread alarm, and should be subjected to close scrutiny. It is impossible to tell how significant is the discovery of arsenic in briquette and gas factories and in the hair and blood of workmen, because no statement is made as to the quantity of arsenic found. The method of reporting positive findings in percentages is misleading when we see that arsenic was found in the hair of 60 per cent. of the workmen, and then discover that that means three out of five. The description of the skin lesions in these cases corresponds with the typical industrial disease of briquette workers as it has been known for many years, but is not characteristic of arsenical poisoning. The skin lesions of arsenic smelters are not nearly so widespread as those of briquette workers, and are characterized by pustules and ulcers, not by warts and keratomata with a tendency to carcinomatous degeneration. The author quotes K. B. Lehmann to the effect that contact with chemicals containing small quantities of arsenic is not particularly dangerous, as is seen among Dutch and Belgian workmen handling zinc white with 0.4 per cent. arsenic for many years without trouble. Koelsch of Bavaria has, during ten years' time, seen very few industrial diseases caused by arsenic and its solid compounds. This is in great contrast to the enormous incidence of so-called arsenical poisoning found by Bayet and Slosse which affected the majority of the workmen and caused epithelioma in no less than 30 per cent. Their theory as to the causation is untenable, and the real agent is to be sought in some organic compound, probably similar to the compounds which cause bladder tumors in aniline workers. — A. Hamilton.

Industrial Trinitrotoluene Poisoning. *C. Rubino.* Abstracted as follows from La Riforma Medica, Dec. 4, 1920, 36, No. 49, 1121, in Il Lavoro, Dec. 31, 1920, 11, No. 8, 234–238. — The experience during the war in Italian munition plants with regard to T.N.T. poisoning was far more favorable than that of Great Britain and the United States. The author made a thorough examination of ninety-nine persons who had worked with T.N.T. from four days to thirty-four months. There was no alcoholism among these people, which explains perhaps why there was no serious poisoning. There was no dermatitis and but one case of icterus. This was in a man 40 years of age who had been employed for three months. He died in coma after sixteen days but no autopsy was made.

The greater frequency of toxic jaundice in British and American T.N.T. workers is probably to be explained by the favoring action of a second poison, alcohol. The most frequent symptom in the Italian workmen was loss of weight, present in 37 per cent. Loss of appetite was present in 18 per cent., headache in 9 per cent., but the symptoms so often observed in the other countries — nausea, vomiting, dizziness — were absent. Anemia was present in 9 per cent. Almost all the workmen passed through a period of slight disturbances followed by a period of adaptation, after which toxic symptoms sometimes appeared, but there were no serious cases of T.N.T. intoxication. Those engaged in nitrating toluol were exposed to irritating fumes of nitrogen oxides and to poisoning by mononitrotoluol. The Webster reaction was found to be of great value, especially as a warning of an impending attack. — Alice Hamilton.

Zinc Chlorid Poisoning. Report of Outbreak among Workers in a Wood Preserving Industry. *Carey McCord* and *C. H. Kilker.* Jour. Am. Med. Assn., Feb. 12, 1921, 76, No. 7, 442–443. — Tars, creosotes and zinc chloride are used in the preservation of wood. The authors describe skin conditions in seventeen patients. The lesions found were as follows:

"(*a*) *Tar Dermatitis.* — Dermatitis venenata, attributable in part to preparations used by employees in 'cleaning up,' such as benzene, light and heavy oils from coal tar distillation, and in part attributable to coal tar distillation products in the tar employed, was observed in only two cases.

"(*b*) *Tar Acne.* — This condition was noted in varying degrees among all the employees examined. It is a common disease among all tar workers and is due to the accumulation of tar in hair follicles, especially those of the forearms.

"(*c*) *Tar Cancer.* — In two cases, lesions were exhibited suggestive of tar workers' or 'chimney sweep' cancer, which has been carefully described by Schamberg. One of these lesions was situated on the scrotum, and the other on the forearm. The quick disappearance

of these lesions under treatment makes one hestitate before making a diagnosis of tar cancer.

"*(d) Zinc Chlorid Burns.* — In addition to the foregoing conditions, all patients presented multiple lesions of the fingers, hands, forearms and rarely of the legs and thighs. All patients gave a history of slight injury, such as abrasion, splinters, burns or crevices from chapping. The typical lesion was a small opening in the skin usually corresponding to the size and shape of the antecedent injury. The surrounding skin appeared normal, but on careful examination it was found to be readily removable. When the initial break in the skin was approximately 4 mm. in diameter, the subsequent impaired skin area was about 12 mm. in diameter. This proportion obtained roughly for all sizes of lesions. On removal of the impaired skin, the underlying tissues were found to be white and bloodless. In the center there was a cylinder of escharotic tissue, the depth of which depended on the duration of the lesion. There was no evidence of infection, and little or no swelling was noted. At times, some of these lesions were exquisitely painful, and others were wholly and continuously painless."

Treatment of the zinc chloride "sores" consisted in removal of the scar tissues and filling in the wound with sodium bicarbonate alone or with petrolatum. Prevention through the use of "linoleated" canvas gauntlets proved entirely satisfactory. — C. K. Drinker.

Absorption and Elimination of Manganese Ingested as Oxides and Silicates. *C. K. Reiman* and *A. S. Minot.* Jour. Biol. Chem., Dec., 1920, 45, No. 1, 133–143. — Ores containing manganese as oxides and silicates are shown to be soluble in the gastric juice. Manganese is absorbed into the blood stream from which it is quickly removed and eliminated by the liver in the bile and by the intestine. The increase in manganese content of the blood after ore ingestion in no case reaches more than twice the normal value and in some individuals no increase is noted. The authors suggest that this difference may be correlated with difference in susceptibility to manganese poisoning. Prolonged feeding of large amounts of manganese to dogs caused no significant changes in manganese content of blood and tissue and produced no pathological symptoms.

The conclusion is drawn that manganese ores are very non-toxic and induce poisoning only in rare individuals who are peculiarly susceptible. — A. S. Minot.

The Blood in Poisoning by Carbon Oxychloride (Phosgene). *Achard, Lebanc,* and *Binet.* Abstracted as follows from Archives de médecine expérimentale et d'anatomie pathologique, March, 1920, in Il Lavoro, Nov. 30, 1920, 11, No. 7, 204. — The authors produced intoxication in dogs by keeping the animals for an hour in a chamber with a capacity of 1 cubic meter, in which was evaporated 1 to 2 c.c. of a 25 per cent. solution of carbon oxychloride. A similar dose for ten to fifteen minutes was enough for rabbits. During the stage of acute edema of the lungs the authors found a pronounced polycythemia, an increase of hemoglobin and of the respiratory capacity of the blood, which they regard as a reaction of the organism against asphyxia. At the same time there is a leukocytosis — polynuclear — which is also evident the day after breathing the gas. The week following the experiment they have often found increased coagulation of the blood and slight diminution of the albumins of the serum. After the disappearance of the acute symptoms there is a progressive diminution in the red cells, in the hemoglobin, and in the respiratory capacity — in other words, a progressive anemia which seems to be of toxic nature. The return to normal state is slow in proportion as the poisoning was intense. — Alice Hamilton.

Studies of Chronic Intoxications on Albino Rats. III. Acetic and Formic Acids. *T. Sollmann.* Abstracted as follows from Jour. Pharmacol. and Exper. Therap., Jan., 1921, 16, No. 6, 463 in Jour. Am. Med. Assn., Feb. 19, 1921, 76, No. 8, 547. — "The immediate occasion for investigating these acids was the question of the safety of the use of formic acid for the preservation of foods. However, the investigation was planned with a view to possible wider applications. Sollmann found that acetic and formic acids behave approximately quantitatively alike, when added to the drinking water of rats in concentration up to 0.5 per cent. and daily doses up to 0.36 c.c. of absolute acid per kilogram of body weight, for from two to four months; this being the sole source of fluid for the animals. Concentrations of from 0.01 to 0.25 per cent., corresponding to daily dosage of 0.2 c.c. of acid per kilogram of body weight, produced no effect on growth,

appetite, or consumption of fluid. They are, therefore, quite harmless. The diuresis described in the literature for formates and acetates, Sollmann believes, must be due to the sodium, potassium or lithium, and not to the formic radical. With concentrations of 0.5 per cent. and daily dosage of 0.36 c.c. of absolute acid per kilogram of rat, the appetite and growth but not the fluid consumption are materially, immediately and progressively diminished with both acids. This is evidently due to their acidity; but the experiments do not throw any light as to whether this is due to local action on digestion, or whether to some more profound disturbance of the acid-base equilibrium." — C. K. Drinker.

## DUST HAZARDS AND THEIR EFFECTS

Industrial Dust. *A. S. Leitch.* Pub. Health Jour., Aug., 1920, 11, No. 8, 341–347; Sept., 1920, No. 9, 396–404. — The object of this paper which was read at the Annual Meeting of the Ontario Safety League in 1920 by A. S. Leitch of Sheldons, Ltd., makers of engines, blowers, fan and exhaust systems, is to call attention to: (1) the various harmful gases, fumes, vapors and dusts produced by industrial processes; (2) the physiological effect which these dusts have on the human organism; (3) present day methods by which they can be eliminated and healthy conditions maintained in the workrooms.

Under headings 1 and 2 a useful account is given of the hazards of various industries and their effects, but the important part of the paper is section 3 in which descriptions in considerable detail and with good illustrations are given of the following:

Hoods for grinding, polishing and buffing letters.

Hoods for use with woodworking machines.

A system for exhausting the dust from the scutching machines, tow dusters and brakes in a flax mill.

A ventilating system for a linotype room.

A supply system for delivering into the room.

A volume of air slightly in excess of that "carried" off by the exhaust fan.

An exhaust system for use in connection with granite polishing, stone grinding, chopping, etc.

Hoods for use in connection with the spray brush method of painting.

The final paragraph of this article is of especial interest as an appeal from industry for the co-operation of science and is quoted in full:

"In conclusion it is to be regretted that so little attention has been paid to this problem by our universities and professional experimentalists. For generations our leading technical institutions have been experimenting on centrifugal pumps, steam turbines, steam boilers, heating plants and other various lines of useful and economical apparatus for industrial and domestic use and are still doing it, yet it is safe to say that none of them plays a more important part in the development of our industries, the safety of human life and the economical production of manufactured goods than does the application of fans and blowers to the removal of fumes, vapours, gases and dusts, all of which have been discussed under the heading of 'Industrial Dust' in this paper." — R. M. Hutton.

Recent Experiments in the Control of Air Dustiness. *O. M. Spencer.* U. S. Pub. Health Ser., Pub. Health Rep., Dec. 3, 1920, 35, No. 49, 2907–2916. — This is a discussion of some of the results obtained in recent studies made by the United States Public Health officers to determine the condition of the air in certain occupations which have a tendency to excite or accelerate the development of tuberculosis. "It is not generally known that there are certain principal occupations creating air conditions that tend to produce characteristic fibroid changes in the lungs, commonly designated as pneumonoconiosis, which changes predispose the worker to infection from the tubercle bacilli." The list of these occupations includes those of cutlery makers, filers, grinders, abrasive workers, polishers, buffers, manufacturers of jewelry, brass workers, finishers, sand blasters, saw filers, toolmakers, glass blowers, glass workers, cotton workers (because of mineral substances used in sizing), marble and stone quarry men, molders, potters, miners of copper, gold, silver, graphite, iron, lead, zinc, mica, phosphate, spar, and quicksilver.

There are standard methods for air purification in general use in industrial plants. These methods take the form of hoods, exhausts, and fume lines usually beginning at or near the work plane and following engineering specifica-

tions, exhausting at a place sufficiently remote and protected to control the hazards arising from the occupation. In some occupations, where such fume lines seem to be unsatisfactory, wet processes have been introduced, the wet process antedating the exhaust as a means of controlling dusty operations. Some observations made by officers of the Public Health Service aroused doubt as to the adequacy of these so-called protective devices, and led to a detailed research. These investigations confirm the doubts and show that in many cases, because of mistakes in planning and installing and because of imperfect methods of determining the efficiency of the devices, operatives have been exposed to almost as great a hazard as though no protective devices had been installed. The greatest need is a method for checking the efficiency of the apparatus, and this check can best be made, not by anemometer or U-tube readings, but by air samples taken at the plane of work and dust counts made from these samples.

It has been the almost universal belief that, in controlling air dustiness, wet grinding is safer and has a smaller dust hazard than dry grinding under an exhaust system. In many instances, this has been shown to be false by studies conducted by Winslow and Greenburg in an ax-grinding factory. Dust counts of samples were collected by the Palmer water-spray machine in the wet and dry grinding shops, and it was shown that the wet grinding was hazardous and gave a false sense of security, and that the exhaust system in the dry-grinding plant was adequate. Other investigations have given similar results. Both processes have dangers and disadvantages. Dust in wet grinding is often caused by the workman who regulates the flow of liquid to suit himself, in order to increase the speed of his work or to protect himself from the spray. With dry grinding, care and attention must be given to the size and location of the hoods, the angle of taper of the ducts, the angle at which the branch pipes enter the main pipe, the use and size of the bends and elbows, the plugging and stoppage of the screens in the hoods, and most important of all, the suction maintained at the terminal hoods. The only entirely reliable means of measuring the effectiveness of the method is the actual dust count at the plane of the work. Circumstances and the character of the work to be done should determine the nature of the safety device to be installed. It may be concluded that the "dust content of a polishing shop can be kept generally under 300,000 small one-fourth standard unit dust particles per cubic foot and should not average over 200,000." — G. E. Partridge.

Lung Inflammation among the Workers with Thomas Slag Dust. *Karl Opitz.* Zentralbl. f. Gewerbehyg., Dec., 1920, 8, No. 12, 223–225. — No study of the dangers to workers in the Thomas slag industries has been made since the voluntary and governmental regulations which greatly decreased the hazards. The typical sickness of these men is a non-specific inflammation of the lungs. The sharp dust and the resulting injury to the lung fabric makes access of a morbific agent easy. Before the regulations the mortality among these workers was as high as 28 per cent. of those employed in one factory. After 1911 the figure dropped to 1.2 per cent. annually, which is twenty times that in other industries. In the sixty German plants with about 2,500 workers there occur about thirty-five deaths annually. Since the industry is rather scattered no one physician sees many cases.

The laws forbid the employment in this industry of females and of men suffering with catarrhal troubles of the respiratory tract, on the supposition that such persons are more susceptible to inflammation. The results have borne out this theory. During the war women were allowed in the Thomas phosphate meal works, catarrhal subjects being excluded. Statistics are available from one plant, a part of a large plant where 20 per cent. of the employees were women. In the Thomas work where regular monthly medical examinations were made, in two years transient catarrhal colds occurred in 5.9 per cent. of the men and 5.7 per cent. of the women. Excluding the epidemic of influenza, serious respiratory diseases caused absence from work in 36.8 per cent. of the women and 27.9 per cent. of the men. During the influenza epidemic, July to December, 1918, the incidence of the disease in the whole plant was 31.1 per cent. among the men, 66.4 per cent. among the women. In the Thomas plant, 73.3 per cent. of the men and 93.0 per cent. of the women suffered from the disease, although the women had all been selected as having less sensitive mucous membranes.

Pneumococci are especially common organisms in the lung cases among the slag workers. The incidence of disease may be cut down by decreasing the numbers or the virulence of

the pathogenic organisms on normal mucosae. Optochin and its derivatives might be used prophylactically at least in those who have repeated catarrhal troubles referable to pneumococci. In any case of numerous colds among the population at large or among the endangered workmen prophylactic treatment with optochin should be used. — E. L. Sevringhaus.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

A Case of Human Glanders. *F. H. Jacob, H. M. Turnbull, J. A. Arkwright*, and *G. M. Dobrashian.* Brit. Jour. Dermat. and Syph., Feb., 1921, p. 39. — This is a carefully investigated record of a somewhat atypical case. Unfortunately, the source of infection remains unknown. Lesions in the skin, the soft palate, a gland from the groin, the lungs and spleen all showed Gram-negative bacilli, which the report states were obviously the Bacilli mallei. Apart from the preponderating number of these organisms, the histological findings were so definite in character that the writers do not hestitate to affirm that these alone indicate the causal organism.

The patient was a farmer aged 31 years. He attributes his complaint to milking a cow whose udder was affected with a series of small lumps discharging water and matter. A previous milker of the same cow is said to have suffered from the same complaint, but he finally became quite well. In August, 1917 the subject of this article noticed a lump on his wrist which grew to the size of half a crown. In three weeks it completely disappeared. From this time until his death a series of these lesions, beginning as small papules and in twenty-four hours attaining the size of shillings and affecting any part of his body, continuously appeared and died away. They were purplish red in color and felt as hard as a Hunterian chancre, when grasped between the fingers. None ever ulcerated except a few at the beginning of the disease. In February, 1918 the patient's throat gave him great trouble and his left tonsil and soft palate broke into deep holes. His temperature ranged between 100° and 102°, but his general condition remained fairly good. During the following September the sores in his mouth ulcerated through the cheek and the destruction of tissues spread rapidly like "cancrum oris." His general health rapidly became worse and he died on September 26, 1918. No evidence could be elicited of anything resembling glanders among his own, or his neighbors' horses, to account for this infection.

A colored plate and photographs illustrate the article. — R. Prosser White.

Tuberculosis among Polishers and Grinders in an Ax Factory. *W. Herbert Drury.* U. S. Pub. Health Ser., Pub. Health Rep., Feb. 4, 1921, 36, No. 5, 159–178. — The author gives the following summary and conclusions:

"1. This statistical study of an industrial establishment developed the fact that a certain group of workers, *viz.*, 'polishers and grinders,' are subject to a very high death rate from pulmonary tuberculosis. . . . The excess death rate among the 'polishers and grinders' indicates that seventy-eight men have died during the past two decades as a result of industrial tuberculosis in these particular grinding shops.

"2. The maximum number of deaths from tuberculosis among 'polishers and grinders' occurs at the age of 45 years, instead of at 25 years as among the other operatives in the mill. This peculiar age incidence and the enormous excess death rate for the 'polishers and grinders' are closely associated with the environmental conditions of the industry, although the problem is complicated by the fact that the grinders also represent a foreign group of low social status and intemperate habits.

"3. In view of the facts brought out by Winslow and Greenburg in regard to the dust content of the air of various workrooms in the plant, it seems clear that the dust produced in wet grinding is largely responsible for the enormous incidence of tuberculosis found in connection with this industrial establishment. The practical conclusion to be drawn from this investigation is that wet grinding, instead of being a dustless and innocuous process, as has commonly been supposed, may, under certain conditions, be a dusty and exceedingly dangerous one, particularly when grinding wheels of natural sandstone are used. When such is the case, every effort should be made to substitute a dry-grinding process properly protected by the installation of exhausts." — M. C. Shorley.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Metol Dermatitis ("Photographers' Eczema"). From Queries and Notes, Jour. Am. Med. Assn., Feb. 19, 1921, 76, No. 8, 540. — "*To the Editor:* — The other day a photographer consulted me for cutaneous lesions around the inner canthi of both eyes, and large areas on the anterior surface of the left knee and groin. The lesions did not have the appearance of psoriasis but rather that of 'weeping' eczema. The family history was negative for psoriasis or other similar skin lesions. Further history elicited that the lesions first appeared about 1912; and at this time the patient began using, in developing, a German preparation called Metol (Hoff), handled solely by G. Gennert, 2426 East Thirteenth Street, New York, which chemical is now widely used in photography. Furthermore, the patient has a friend who cannot come into the room where this product is used without having, as a result, intense itching and a fine papular eruption on variable places of the body.

"The indexes of The Journal, for several years back, give no information on this subject. Can you give me any source of information on this subject?

"Answer. — Workers in photographic establishments, especially those engaged in the developing process, are exposed to a number of industrial poisons, such as bromin, chromium, 'metol' (a trade name for mono-methyl para-amido metacresol sulphate), cyanogen, platinum, vanadium, anilin and mercurial compounds. Kober and Hanson (Diseases of Occupation and Vocational Hygiene, Philadelphia, 1916, p. 616) state that 'in an examination of forty studios in Chicago by Dr. Karasek, platinum paper was found to be the cause of eight cases of poisoning, characterized by "pronounced irritation of the throat and nasal passages, causing violent sneezing and coughing; bronchial irritation, causing such respiratory difficulties as to preclude the use of the paper entirely for some individuals, and irritation on contact with the skin, causing cracking, bleeding and pain." Metol poisoning, characterized by an erythematous rash of the hands and arms, occasionally involving other parts of the body and giving rise to ulcers, was found in thirty-one cases in this same study. The developing process frequently gives rise to inflammatory conditions of the hands (eczema), ulcers and pigmentation unless protected by rubber gloves.'

"The so-called 'photographers' eczema,' the most common disease of this occupation, is due to 'metol.' In an answer to a query in this department several years ago (Metol Dermatitis, The Journal, Feb. 15, 1915, p. 610) concerning the method of treatment for this condition, it was stated that:

"There have been various recommendations for prophylaxis and treatment. Coating the hands with petrolatum before beginning development is a useful precaution. L. A. Freeman (*British Journal of Photography*, June 5, 1914) recommends that 2 drops of pure phenol (carbolic acid) be added to a quart of cold water. Immerse the hands in it after the use of metol, and warm gently over a gas flame until the heat is no longer tolerable. Then wash thoroughly with carbolic soap and dry well.

"Before the skin is broken, N. T. Beers (*New York M. J.*, Sept. 10, 1908; abstr., The Journal, Sept. 26, 1908, p. 1107) recommends soothing applications, such as lead lotion. After the skin is broken, care must be taken to protect the parts thoroughly and to use the blandest of applications. Zinc stearate with 1 or 2 per cent. of phenol or salicylic acid makes a useful dusting powder. In the later stages, more stimulating applications may be used, such as small amounts of oil of cade or of resorcin or ichthyol.

"This ointment has been advised: ichthyol, resorcinol, glycerin, of each, 1 ounce; zinc oxid, ½ ounce; white petrolatum, 6 ounces (*Brit. J. Photog.*, Nov. 7, 1913, p. 860)." — C. K. Drinker.

Affections of the Retina and Optic Nerve Caused by Arsenical Poisoning. *H. K. de Haas.* Abstracted as follows from Arch. Ophth., 1919, 99, p. 16; Zentr. Biochem. Biophys., 21, p. 345 by H. S. Paine in Chem. Abstr., Nov. 20, 1920, 14, No. 22, 3465. — "As was detected in the urine of 55 out of 58 patients with inflammatory modifications of the retina and optic nerve. H. describes the clinical aspect of arsenical neuroretinitis. The occurrence of arsenicuria was established by use of sensitive methods and careful technic. Normal urine is free from As. The urine contained an average of only 13.7 mg. $As_2O_3$ per l. in arsenical neuroretinitis."

Industrial Myopia and Selection of a Trade. *R. Schneider.* München. med. Wchnschr., July 30, 1920, 67, No. 31, 892. — The material for this study was obtained from the record of the refraction of 5,600 troops who were sent to an eye-station behind the western front during the period from August, 1917 to March, 1918. No cycloplegic was used, and the cases of simple and mixed astigmatism were not considered. The men were classified into six groups, according to their civilian occupation, as follows: farmers and farmhands; unskilled workmen and day-laborers, factory hands, railroad men, and chauffeurs; workmen with coarse hand-work, such as gardeners, masons, carpenters, smiths and bakers; workmen with fine hand-work, as typesetters, printers, photographers, draftsmen, painters, musicians, sculptors, watchmakers, and opticians; merchants, booksellers, students, officials without higher education; and men with higher education, and labor officials. It was found that:

1. There were many more myopes in the higher groups.

2. In spite of the myopia, the visual acuity was much better in those who did near work.

3. The lower (−0.25 to −3) and middle (−3.50 to −8) grades of myopia were more common in the higher groups, but the higher grade (above −8) was five or six times more common in the two lower groups than in the sixth.

4. Those in the higher groups who had the higher grades of myopia had a better visual acuity than those in the lower groups with the same grade of myopia.

Professor Schneider thinks that these findings can be explained for the most part by selection and elimination. For instance, merchants and students find that a moderate degree of myopia is advantageous when presbyopia comes on. As Weismann, the great student of heredity, says, "the nearsighted linxes, falcons, and gazelles were destroyed by natural selection, as was the myopic Indian; but the nearsighted European of the upper classes finds business and bread." In some trades the myope is eliminated by law (*e. g.*, postal service, railways, sea) or by prejudice against glasses (waiters). Some reasons why myopes of high grade are found in the lower groups are: their low visual acuity, the teaching that they should get work that does not require close application, and the avoidance of marriage by those in the upper groups who have extreme myopia. — H. G. Noyes.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

A Standard Schedule as an Aid to Uniformity in Accident Reporting. *Leonard W. Hatch.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 252–253. — With a view to establishing a simple and convenient uniform blank for the legal reporting of industrial accidents, the American Association for Labor Legislation has drawn up a standardized form, given in full in this article, which it urges all states to adopt. — Elizabeth C. Putnam.

Nucleus for Accident Prevention Library. Safety Engin., Dec., 1920, 40, No. 6, 268. — This list was compiled by Miss Keller, librarian of the Independence Bureau, Philadelphia, with the advice and approval of the accident engineers of the Bureau. — M. Dent.

Occurrence and Prevention of Industrial Accidents. *J. Alexander.* Abstracted as follows from Baltimore Gas and Electric News, in Personnel, Jan., 1921, 3, No. 1, 8. — The author draws attention to the following factors in accident prevention:

1. Provision for proper lighting and ventilation in industrial plants.

2. Adoption of safeguards on all machines, etc., that are likely to cause accident.

3. The avoidance of loose clothing of any kind that may become entangled in a belt or gear.

4. Goggles should be provided and worn whenever there is danger of foreign material flying in the eyes.

5. Tools of every description should be properly racked in a convenient location and the floor kept clear of all material that might result in a fall.

6. Habitual carelessness of employees should be strongly suppressed even though it entails the transfer of the offender to some other department where the work is of the fool-proof variety.

7. Repeated medical examinations should be required of all employees engaged in hazardous

occupations in order to determine their physical fitness for that particular class of labor.

8. Prompt and skilled surgical attention should be obtained immediately after injury.

Avoidance of overfatigue, a careful attention to all minor cases of sickness with a close observance of the ordinary rules of personal hygiene will further our effort to assist the employee in accident prevention at his particular plant or station. — M. Dent.

Saving Men and Money. *L. Resnick.* Nat. Safety News, Dec. 6, 1920, 2, No. 23, 3-7; 11-12. — The safety and medical work of the Bethlehem Steel Company is here described. The corporation operates four plants employing altogether about 31,000 men, and the building up of the medical and safety work has been given serious attention. In the aggregate, the results which have been obtained, measured in terms of saving of life and time, appear very decisively to justify the effort and expense. The figures for the first ten months of 1920, compared with those for the preceding year, show for all the plants a reduction of 55 per cent. in fatal accidents; of 70 per cent. in accidents resulting in the loss of eyes; of 50 per cent. in accidents resulting in loss of legs or feet. During the year 1919, the accident severity rate, measured in days lost per hundred men per month was 15.3, while for 1920 the rate was reduced to 13.73 — an equivalent of the full time of twenty men for the whole period of ten months.

In 1910, when safety work was in its infancy, at least 50 per cent. of the injuries in industry became septic wounds, while the present record of the Bethlehem Steel Company shows that during 1920 not a single case of infection appeared in many thousands of cases treated in the company hospital. Before 1913 nothing that could be called organized accident prevention was done at Bethlehem, but since then the medical work and safety work have been greatly extended and thoroughly organized. Each of the plants has its safety superintendent, assisted by an office staff and two outside safety inspectors, who also act as first-aid instructors. In addition to these there is an army of unpaid, permanent safety committeemen; there are more than 4,000 men in the Bethlehem steel plants who have received thorough training in first-aid work. For several years there has been in operation in the Bethlehem plant a guard-making shop employing about fifty men, who are constantly busy repairing, making, and installing safeguards, and who equip an average of 4,000 machines a year.

Recently the safety department of the Bethlehem Company became dissatisfied with its work. Upon investigation it was found that the organization was cumbersome, that the departmental committees, because they were composed entirely of workmen, were not receiving proper attention from the foremen, and that the safety department was hampered because there were still thousands of workmen in the plant who understood little or no English. The department was, therefore, subdivided, superintendents of the various steel plants were asked to become responsible for safety work in their departments, and classes were established to teach the English language and arithmetic. The result of the reorganization appears in the form of a steady reduction in lost time. — G. E. Partridge.

Five Months without an Accident: Record of Sheepskin Workers. Nat. Safety News, Jan. 17, 1921, 3, No. 3, 7. — Nine of the seventeen subdivisions of the A. C. Lawrence Leather Company of Peabody, Mass., are reported as having an absolutely clean accident record for the first five months of 1920. Two divisions made the same perfect record during the entire year 1919, making seventeen months, therefore, during which no person lost a day because of injury received during work.

The time-lost records for all divisions of the sheepskin department of this company average lower than one man's time per thousand men lost per day for each month. Each member of the safety committee of this plant is selected from a section doing a certain class of work, is given the title of safety director of his unit, and is responsible for the safety work in that unit. — G. E. Partridge.

The Question of Increased Protection against Accidents for Industrial Workers Who Were Injured in the War. *H. F. Ziegler.* Zentralbl. f. Gewerbehyg., Dec., 1920, 8, No. 12, 232-236. — It is more necessary than ever to take safety measures in the training and employment of men who were injured during the war. Suggestions are given from the devices and practices at the Siemens-Schukkert works near Berlin. The inspectors and the labor unions have pronounced these methods completely satisfactory. Many blind men are

employed here at machine work. All rotary and moving parts are enclosed. Electric unit drive is valuable. Automatic conveyors aid in the system. Adequate illumination and clear floor space are essentials. Care must be taken that these men are not exposed to the danger of coal tar products or to the skin lesions of inferior oils. To guard against injuries to fingers and hands, punches are so made that both hands are needed to operate the machine. Sharp edges of tools and products are guarded. Openings for material to fit into machines leave no room for a hand beside the metal. Rivet machines have wire cages which automatically push the hands out of the way of the moving parts. The measures are so effective that in three years with 114 reported accidents only three came from this plant, all of which were slight. No blind men were involved in accidents. — E. L. Sevringhaus.

Getting Rid of Ladder Accidents. *W. Dean Keefer.* Nat. Safety News, Jan. 3, 1921, 3, No. 1, 4–5. — It is estimated that in 1919 about 1,000 persons were killed by falls from ladders. Many more each year are permanently disabled by such accidents. To prevent them, certain rules about the construction of ladders should be adhered to. For stationary ladders: (1) a clearance of not less than 6½ inches should be provided back of the ladder rungs, to allow firm hold upon the rung; (2) a continuous clearance, in front, of at least 30 inches, and at least 15 inches on each side of the center line of each ladder should be allowed, so that a cramped position will not be necessary in climbing the ladder; (3) wherever possible, long stationary ladders should be built in zigzag sections with safety platforms about every 20 feet; (4) the side rails of the ladder should be extended at least 45 inches above the landing; (5) stationary ladders more than 30 feet in length should be provided with a well-basket or cage guard.

Portable ladders which are always made of wood, should never exceed 30 feet in length. The best materials should be used and great care taken to see that the ladders are in good condition and free from splinters. The method of fastening the rungs to the side rails is an important point. They should always be inserted in holes and never nailed or screwed to the outside. There are many types of ladder feet and safety shoes, none suitable for use on all kinds of floors. For rough or wooden floors, the bases should have case-hardened steel spurs or disks, or lead-footed bottoms. On concrete and rough iron floors, shoes of lead or other abrasive substance are good. For wet and relatively smooth floors recessed rubber bases have given the best satisfaction. On some floors, nothing in the way of shoes is safe, and the only method is to tie the ladder or have it held at the foot. Whenever possible, ladders with a goose-neck or hook at the top should be used.

Step-ladders are subject to hard usage, and great care is necessary in providing proper strength and rigidity. They should never be more than 20 feet in length, and it is essential that each step be reinforced and secured to the side rails by other means in addition to nails. Another important point is the provision of the metal automatic locking device or spreader to hold the front and back rails apart. To have the proper pitch, the spreader should be so arranged that when the ladder is open, the spread at the bottom between the front and back rails will be greater than the spread at the top by an amount not less than 1½ inches for each foot of ladder length. All ladders should be kept clean; iron and steel ladders should be coated with a preservative paint or composition, but wooden ladders should never be painted, since paint is likely to cover imperfections. Each ladder should be numbered and subjected periodically to inspection. — G. E. Partridge.

Safety in the Construction Industry. *F. A. Davidson.* Safety, Nov.–Dec., 1920, 8, No. 11–12, 181–192. — The author believes that the modern safety idea can be applied to the construction industry as it has been in other lines. This industry cannot afford to postpone the taking of vigorous action to reduce accidents if only as a business proposition. The necessary practical steps to accomplish this action are outlined as follows:

1. The insistence by executives that accidents be eliminated.

2. The arranging for complete co-operation between the various divisions of each individual company and also between different construction companies.

3. The compiling of standard accident records.

4. The utilization of every practical means to educate the field forces in safety.

5. The taking of every precaution to have all of the mechanical features of construction work thoroughly safe. — G. M. Fair.

Hand Tools. National Safety Council. Safe Practices No. 39, pp. 16; Machine Shop Machinery. Safe Practices No. 40, pp. 16; Suggestion Systems. Safe Practices No. 41, pp. 15. — A representation of accident hazards with hand tools and machine shop machinery, and suggestions as to the best practices for their elimination. — M. Dent.

Inspections for Hazards in Lumbering and Logging. *C. O. Hero.* Safety Engin., Dec., 1920, 40, No. 6, 258–262. — A description of the sawing, lumbering, logging, and veneering operations, and the various dangers to which men are subjected while engaged in them. The author concludes with the truism that safety education is the best possible way of eliminating accidents. — M. Dent.

The Hazards of the Logging Industry — Mechanical vs. Human. *W. Graham Cole.* Safety Engin., Dec., 1920, 40, No. 6, 253–257. — Although it is generally agreed that from 75 to 80 per cent. of all industrial accidents are preventable, in the logging industry no attempt has been made until very recently to apply safety methods. This industry is carried on by backwoodsmen, prone to do as their fathers and grandfathers before them have always done. They are trained to the knowledge that theirs is a dangerous living, and it has not occurred to them to try safer methods.

A table is given showing the causes of accidents in the logging industry, the most notable of which have been extracted and listed here: (1) fall of trees — the most frequent and severe type of accident. Accidents from the "kick-back" of falling trees are preventable by the use of the V-Bed method in sawing; (2) hand tool accidents; (3) railroad operations; (4) various causes, such as handling explosives, animals, machinery, cables, chains, blocks, etc.

The men being rough and careless, the most needed step is to educate them in precautionary methods. — M. Dent.

Engineering Problems in Dust Explosion Prevention. *David J. Price.* Chem. and Metall. Engin., Jan. 5, 1921, 24, No. 1, 29–32. — After discussing the types of industrial plants in which dust explosions may occur, the writer takes up the causes of explosions by comparing this type of explosion with a gas explosion to which it is similar in all its salient characteristics, except that the particles in a dust cloud are larger than the minute molecules in a gas mixture. To produce either type of explosion it is necessary that a proper mixture of gas, or dust, and air and a source of ignition be present. The writer has studied the ignition temperatures of gases and dusts, the propagation and velocity of the flames, the pressures developed by the explosion and the relation of humidity to explosion frequency. — G. M. Fair.

## INDUSTRIAL SURGERY

A Case of Industrial Injury in a Cooper. *W. Smital.* Zentralbl. f. Gewerbehyg., Dec., 1920, 8, No. 12, 228–231. — Details are given of a 36-year old cooper who had suffered three different times in twenty-two years of such work from a painful callous tumor on the hypothenar eminence of the left hand. There was a slowly developing loss of muscle sense in the left hand and forearm causing him to drop his tools. The condition was cured by removing the callous skin and also beneath this layer a purulent cyst with a callous covering. The first two treatments were by incisions, the latter, by the author, was a softening of the tissue with baths and salicylic plasters, followed by painless removal of the masses. There was evidence of involvement of the palmar fascia.

The continued trauma to the hand from the use of a hammer with a metal ferrule on the handle caused the callous to develop and also gave rise to a mucous cyst. This tissue is very friable, and during work in cold water in winter infection easily enters through cracks. Infection reaches the cyst and causes painful inflammation. An inspection of the hands of a large number of coopers showed such left hand callous places, and there were many histories of winter inflammations in the region. — E. L. Sevringhaus.

A Peculiar Injury Due to Black Italian Thread. *Otto Sachs.* Wien. klin. Wchnschr., July 19, 1920, 33, No. 34, 752–754. — A case is described in which a seamstress abraded her little finger with black thread made in Italy. Tissue necrosis occurred and the wound spread,

refusing to heal under local treatment. Secondary infection followed. Excision of the focus permitted early healing. Chemical examination and animal experiments demonstrated clearly that the cause of the necrosis was primarily due to the aniline dye known as "ice-black," a lipoid-soluble azo dye similar in structure to amido-azotoluol. Austrian black thread is dyed with aniline black, which is harmless. — Barnett Cohen.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Practical Methods of Reducing Fatigue. *Frank B. Gilbreth* and *L. M. Gilbreth*. Mod. Med., Jan., 1921, 3, No. 1, 22. — In this article the fact is set forth that as much data as any individual may collect on the elimination of fatigue will be of great value to those who are devoting themselves to the scientific study of this important industrial question. To have more data is of greater importance than to dispute as to the relative efficiency of present methods and devices. To obtain these data let each man analyze his process of work in terms of motion and the resulting fatigue, with the aim of devising the one best way to do the work. This will add greatly to the amount of attention devoted to these special problems.

All material should be carefully checked and revised by a trained laboratory worker in order to attain the greatest economy of effort and the most profitable and permanent results. To test the value of rest periods is a matter for experts and careful trial and study.

A method of study for reducing fatigue is suggested which includes the worker, the surrounding conditions and tools, and motion study. Motion study is analyzed according to types of motion and also to cycles of motion. The types of motion are (1) those which require the worker's best effort and ability; (2) those which are performed with the ease and pleasure of habit; (3) those which soon are reduced to dull monotony. The work should contain the right balance of these three types. The cycles of motion are the various combinations of the sixteen elements of search, find, select, grasp, position, assemble, use, disassemble, inspect, transport, load, pre-position for next operation, release load, transport empty, unavoidable delay, and rest for overcoming fatigue.

The cost of studying fatigue reduction could be lessened by the application of each to his own task but in any case the cost is quite justified by the results in increased efficiency. — Elinor D. Gregg.

## HEAT, COLD AND HUMIDITY

A Preliminary Study of the Physiological Effects of High Temperatures and High Humidities in Metal Mines. *R. R. Sayers* and *D. Harrington*. U. S. Pub. Health Ser., Pub. Health Rep., Jan. 28, 1921, 36, No. 4, 116-129. — "1. In still air in metal mines, with a wet bulb temperature over 90° F. and under 100° F., and with a relative humidity of 89 per cent. or higher, the following signs and symptoms were found, even when little or no exercise was taken:

"1. Blood pressure, systolic and diastolic, fell rapidly.

"2. Body temperature rose; in one case it reached 102° F., and this after less than two hours having been spent in the hot, humid air described.

"3. Pulse rate increased and seemed more sensitive to exercise than normally.

"4. Perspiration was very profuse.

"5. Dizziness was a common symptom, and sometimes was marked.

"6. Physical weakness or exhaustion was marked in some cases and present in all.

"7. Inability to think quickly or accurately was a very common symptom.

"8. Nausea was occasionally found.

"9. Headache was also occasionally found.

"10. Loss of weight was especially marked in men who had been employed under above conditions over a period of years, but occurred even after exposure only a few days.

"11. In still air, with wet bulb temperatures of from 85° F. to 86° F. and a relative humidity

of 96 per cent., there were no marked changes in the blood pressure or body temperature, nor were the symptoms dizziness, physical weakness, and inability to think or act quickly, mentioned in I, found as long as the subjects remained at rest or took only light exercise. When moderate exercise was taken — climbing up and down an eight-foot ladder fifteen times in five minutes — the blood pressure and body temperature rose somewhat.

"III. Blood-pressure readings taken after the subject had reached the cool air of the surface were found to vary considerably with men unaccustomed to high temperatures. Under conditions which resulted in a rise of body temperature to 100° F., or more, the systolic pressure fell, but where the conditions were such as not to cause the body temperature to rise above 100° F., there was a rise in the systolic pressure when the subjects reached the surface. In one man, long accustomed to hot, humid air, a fall of systolic pressure was also found. In three others, not accustomed to the conditions mentioned, there was a rise of systolic pressure.

"IV. It was found that the body temperatures reached normal in from one to two hours after the subjects had reached the cool air of the surface after having been subjected to conditions that caused a rise above 100° F.

"V. It was noted that a shower bath, beginning with tepid water and ending with a dash of cold water, had but little immediate effect upon the body temperature." — M. Dent.

## WOMEN AND CHILDREN IN INDUSTRY

The New Place of Women in Industry. IV. Women of the International Harvester Company. *Ida M. Tarbell.* Indust. Management, Jan. 1, 1921, 61, No. 1, 51–57. — In the International Harvester Company women are now regarded as permanent operators on a variety of light machine shop operations which five years ago were thought to be beyond their capacity. The women's work is not men's work, nor is it the work of trained mechanics, but rather such work as was formerly done by young men of 18 or 20 years of age. On such work women are regarded as far superior to boys because they show more interest in their work, are quicker, and take better care of their equipment. The range of operations which the International Harvester Company thinks that women have mastered includes all kinds of operations on lathes, drill and punch presses, milling and screw machines, grinders and polishers, and gear hobbers. Women are regarded as especially good in the work of inspecting. They are more tractable than men although, despite danger, most women will not adhere strictly to rules in regard to uniform. — G. E. Partridge.

Night-Working Mothers in Textile Mills, Passaic, New Jersey. *Agnes de Lima.* Published by the National Consumer's League and the Consumer's League of New Jersey, Dec., 1920, pp. 18. — This pamphlet is not primarily a statistical study. It is an exposé of human relations in industry as conducted in the textile mills of New Jersey. The restrictive legislation in regard to night work of women in the state of New Jersey has been repealed. Hence conditions obtain in that state (even in government owned property) that are the more lamentable in that the same industry exists with no night work of women in the nearby states of New York, Massachusetts, Connecticut and Delaware.

The investigation was carried out from door to door, aiming to secure a general picture of home life rather than mere lists and tabulations. The opinion of the community was ascertained as to the value of night work. It was condemned but chosen by the operatives as better than leaving the children alone all day or trying to live on the wage paid to the men.

The picture of Passaic is that of a town of many large textile mills, in which the labor is Hungarian, Polish, and Russian. The United States Bureau of Education finds an unusually high rate of illiteracy. All attempts to remedy this have failed, due to the suspicion and distrust caused by the employer's policy of espionage and black-listing for union activity.

The salient facts brought out are: that it is the younger married women with three or four children who are to be found in the night shift; that the children are neglected; that the mothers are perforce up most of the day averaging about five hours of interrupted sleep; that there is no regulation even as to pregnant women being on the night force; that night work for

women is fostered by the low wage scale for men, coupled with a comparatively high wage level for women (and more for night work), which tempts them into industry. Even when running only three days a week, the night shift is maintained.

It is evident to the Consumer's League that the managers of this industry in New Jersey must be forced by legislation to do what all enlightened manufacturers do for their own benefit. We can scarcely afford to let the ignorant manager drag down our industries by abusing the vitality of our workers. — Elinor D. Gregg.

The Child Labor Problem. *Harold H. Mitchell.* Pub. Health Nurse, Jan., 1921, 13, No. 1, 27–29. — The author makes a plea for careful examination and periodic re-examination of children in order to secure early diagnosis, and to give advice through clinics for preventive hygiene. The public health nurse will be the agent by whom this service is understood and made effective.

The present state of protection offered to the adolescent working child is quite unorganized as the laws in different states vary. More evidence is needed on physical tests for various industries and standards of physical fitness should be established. The United States Children's Bureau has made a tentative report on standards of moral development and physical health. The great weakness of the present laws lies in their non-enforcement. Yet there should be no difficulty in establishing medical examination in the continuation schools. The re-examination might very well take place there also or when a change of work is being made.

Public health nursing services must be depended upon for co-operation in securing hygienic conditions in the home. There are many loose ends to be picked up in order to prevent these children from becoming incompetents, dependents and discouraged failures. Research work in this line is needed to present the problem as it is today clearly and adequately. — Elinor D. Gregg.

One Thousand Industrial Accidents Suffered by Massachusetts Children. *Lucile Eaves.* Am. Child, Nov., 1920, 2, No. 3, 222–232. — Records of cases reported to the Massachusetts Industrial Accident Board were studied by the students in the School of Social Work of Simmons College. The reports indicate that males of all the ages included are more subject to industrial accidents than females, and that more than half of the accidents were due to the wage-earning employments of the children. The need is emphasized of safety committees whose activities may be stimulated by encouraging competition in the promotion of low accident rates and by offering rewards for suggestions which will increase safety. There is also need of thorough instruction concerning the dangers peculiar to local industrial establishments — instruction which might well be given in continuation and other vocational classes. — G. E. Partridge.

Conserving Children in the Industries of Massachusetts. Mass. Dept. Labor and Industries, Indust. Bull. No. 15, Boston, 1920, pp. 21. — The establishment of continuation schools in Massachusetts affords opportunity for imparting to working children valuable knowledge in regard to the hazards incidental to modern industry. At the present time accidents are very numerous, and notwithstanding the plain requirements of the statutes many serious violations take place. But with forty-four continuation schools now established in Massachusetts, attended by about 30,000 children, it seems hardly possible to believe that these violations of the statutes could exist without the knowledge of the teacher of the continuation school. Co-operation between the continuation school teachers and the Department of Labor and Industries would operate to the advantage of the child. Co-ordination of the activities of the Division of Industrial Safety, the inspection force of which frequently visits all the industrial centers in the state, with the work of the teacher in the continuation school would be a most effective means of instructing children in regard to industrial hazards, and of teaching them the fundamental principles of safety.

During the year ending June 30, 1919, as the report of the Industrial Accident Board shows, 1,691 children between 14 and 16 years of age sustained tabulatable injuries — *i. e.*, injuries arising out of employment and causing incapacity for longer than the remainder of the shift or the day — ten ending fatally and sixty-two resulting in permanent partial disability of the child. Tables are given showing the causes of these injuries, precisely the process during which the accident occurred, and

the nature of the injury received. From these tables certain practical conclusions may be drawn, such as, for example, that nearly all the serious accidents sustained by children between the ages of 14 and 16 years are preventable. In almost every industry a traditional habit is responsible for numerous injuries, such as, in textile establishments, the practice of picking cotton waste from moving machinery. — G. E. Partridge.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

"Health First" Campaign: Outline for Industries. *G. J. Soderberg.* Personnel, Jan., 1921, 3, No. 1, 1, 5. — First, there should be a comprehensive survey of the ground and of the buildings, which would include inspection of land drainage, care of rubbish, construction and care of walks, condition of roofs, general floor conditions, floor cleaning and dust elimination, plumbing, drinking water, ventilation, disposal of dusts, fumes, gases, and noises, lamp shading, seats and clothing for workers.

There should be systematic cleaning of floors by any method that eliminates dust, preferably after working hours. Painted floor lines are recommended as means of insuring maximum speed in movement of production and of workers. Water-closets, wash basins, slop sinks and drinking fountains should be of vitreous china, or good grade of white baked enamel over iron. Common cups, common towels and the like should be entirely abolished. Toilet rooms should be painted with enamel or other hard surface. Setting up exercises for a five-minute period during the forenoon and again in the afternoon are good for sedentary workers. Adjustable chairs for women workers at machines will pay well. Bare lamps should be shaded, dimmed or otherwise protected to eliminate glare, and should be properly placed. Goggles or masks should be provided for workers where there is excessive dust, or hazard from chips, etc. Physical examination of employees as a condition of accepting work might be required, especially for workers on heavy tasks. Attention to clothing is important. Finally, the industry should keep in close touch with industrial health bureaus and other helpful organizations. — G. E. Partridge.

Hygienic Precautions to be Observed in the Manufacture and Industrial Use of Carbon Disulfide. *Jules Blain.* Abstracted as follows from Industrie Chimique, 1920, 7, 311–313, by S. D. Kirkpatrick in Chem. Abstr., Jan. 20, 1921, 15, No. 2, 281. — "Workers handling $CS_2$ under unsatisfactory hygienic conditions are subject to serious intoxication resulting in neurotic disorder and greatly lessening their capacity for work. Certain types of workers are more susceptible than others; especially is this true with alcoholics and others of weakened vitality. Medical examination of all employees at regular periods and the immediate examination of those complaining of symptoms such as eye fatigue are recommended. Among the industrial uses for $CS_2$ are extracting grease and oil from bones (to be used for bone black), from seeds and oilcakes; degreasing wool; purifying paraffin; extracting perfumes; dissolving S from its minerals; manufacturing of liquid fire, certain types of varnish and rubberized cloth, and in the vulcanization of rubber by the cold (Parke) process. In all of these industries the factories should have high ceilings and adequate ventilation; periodic medical examination is recommended wherever possible. Great Britain has stringent laws regulating factories making rubberized cloth. A diagram is shown of a filter for removing sulfur-carbon compounds from the air by means of crude petroleum and $CaCl_2$." — M. C. Shorley.

Suggestions on Heating and Ventilating Paper Machine Rooms. *Edward A. Ryan.* Abstracted as follows from Jour. Engin. Inst. of Canada, Jan., 1921, in Nat. Safety News, Feb. 7, 1921, 3, No. 6, 12. — "The chief advantages of a properly designed and operated ventilating system, according to Mr. Ryan, are increased production due to fewer shutdowns, greater safety for the workmen because of better illumination when the excess vapor is carried away, a more even product resulting from uniform humidity and temperature, and a longer life for machine felts due to decreased moisture content of the air in the machine room." — M. C. Shorley.

# INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Fundamental Requirements for Successful Medical Work in Industry. *W. A. Sawyer.* Mod. Med., Jan., 1921, 3, No. 1, 23–26. — The first essential for industrial medical practice is a sympathetic co-operation from the heads of the organization. The second is adequate personnel — adequate in quantity and character. Third, is the equipment adapted to the needs of the department? Fourth, a program in which ideals plus daily practice will result in consistant growth. The point of departure to secure this fourth requisite is a complete and painstaking physical examination. The reasons given for this examination are as follows:

1. For the purpose of placement or exclusion. The interest and co-operation must be secured at this point.
2. Periodic re-examination for possible hazards and advice as to corrections. This should be for rank and file, executive and all, and careful records kept and studied.
3. It contributes to reduction of absenteeism.
4. It contributes to longevity of service.
5. It dovetails with outside public health work.
6. It leads into all other medical work in industry.
7. The future of medicine lies in prevention of disease. This must be taught to the lay mind. Physical examination should protect from ill-advised treatment and from neglect of important conditions. — Elinor D. Gregg.

Economy of Proper Medical Treatment. *Paul B. Magnuson.* Mod. Med., Dec., 1920, 2, No. 12, 799–802. — In a paper written in the light of experience as chief surgeon of several large corporations and as medical director of the Industrial Commission of Illinois, Dr. Magnuson emphasizes the fact that from every point of view the first consideration in industrial accidents is the selection of a thoroughly good surgeon. When "the new theory that industry as a whole should stand the loss incident to accident to employees" was enacted in law, some of the more far-sighted corporations began to furnish surgical attention to men injured in their plants. Unfortunately, however, the doctor was considered primarily as an adjunct to the claim department and his training, competency and ability to handle men, were of little importance. The employment of a physician on this basis is an uneconomical start from the social point of view, because the physician comes into closer contact with the employees than almost any other department head and thus has it in his hands to make or mar good relations between management and employees. For example, one surgeon "took charge of a large industry which was perfectly controlled in its organization by the union, and within a year of the time he took charge he had also been elected official examiner for that union. This same man saved that company, the first year of his employment, $20,000 in the claim department, in spite of the fact that the number of accidents increased 10 per cent. over the previous year; and as against thirty-one lawsuits filed the year before he took charge, there was one lawsuit filed the first year of his employment. . . . It would be hard to convince this company at this time that a man with small training is an economical man to employ."

The employment of a second-rate physician is also — and more obviously — uneconomical from a professional point of view. In his hands the diagnosis of an apparently simple case is made in a haphazard way, with sometimes serious and very expensive results. A man in construction work, for instance, who falls from a height and strikes the ground on his feet, has probably received a fracture of the os calcis of one or both feet. If, as in most cases coming before the Illinois Industrial Commission, the fracture goes unrecognized and the man is treated for a sprained ankle only, a very serious condition develops, "the man has a foot which grows progressively worse with use and finally, in a large number of cases, loses from 50 to 90 per cent. of the use of his foot, which totally incapacitates him for any occupation that involves climbing, or walking on scaffolding or uneven ground. If these cases are taken in time and properly treated, the major part of this disability can be averted, and the surgeon who prevents one of these disabilities saves a considerable portion of his yearly salary on one case alone, although it may be much better than the ordinary salary paid industrial sur-

geons." Other similar and common instances are cases of back injury which are diagnosed and treated as simple strains and which consequently drag on from month to month; inflammed bursae of the shoulder, from which entirely unnecessary adhesions and weakness result if the arm is immobilized in the wrong position, and the process of getting back to the normal is long and painful; a broken limb which is allowed to remain too long in fixation dressings and is consequently a very painful thing to move. In cases such as this latter, another element enters in the mental attitude of the patient toward the management. If nothing is done for the broken member, although it is so useless and painful; after the bone has healed, there is little wonder that neurosis develops; the habit of pain becomes firmly fixed in the patient's mind, especially if he feels he is being neglected by those whom he also feels are responsible for his injury. If the surgeon knows enough to remove the cast as soon as possible for gentle massage each day, the patient "not only receives results on the injury but he feels that there is something being done to hurry his recovery. His mental attitude remains that of a man who is friendly."

The wise employer will appreciate these social and professional factors and will select the best doctor he can get with the most complete training; he will feel that this is the best investment, because such a man will inspire confidence in the employees, smooth the way for amicable adjustment of claims, make a small percentage of disability where there may have been a large percentage, prevent disabilities where they are preventable, and save his salary every three months for any large employer of labor, to say nothing of sparing the human race the trouble which is brought about by disabilities. Such service is adequate and, in the long run, economical. — Elizabeth C. Putnam.

Why Physical Examination? *J. P. Austin.* Personnel, Feb., 1921, 3, No. 2, 5. — The advantages of physical examination and consequent treatment of diseases and injuries are found to be: (1) minimizing loss of time and accidents; (2) minimizing absenteeism, tardiness, and the inefficiency due to illness; (3) improving general health; (4) giving employees tasks equal to their physical powers; and (5) improving each individual. — M. Dent.

Keeping Workers Well. Factory, Nov. 1, 1920, 25, No. 9, 1520-1524. — Among the items under this heading is one entitled "Examining New Employees." The National Malleable Castings Company follows a very definite procedure in its medical examinations. Besides heart and lung tests the worker is examined for spinal and abdominal defects. The extremities are carefully inspected also. The full procedure is given in this article under sixteen headings. — C. H. Paull.

Physical Examinations of Industrial Workers. *F. L. Rector.* Jour. Am. Med. Assn., Dec. 18, 1920, 75, No. 25, 1739. — A statement obtained through the use of a questionnaire sent to 100 industrial establishments.

"The results of the board's investigation of physical examination of industrial workers may be thus summarized:

"1. Thirty-four replies were received, including fifteen industries and 410,106 employees, of whom 327,183 were men and 82,923 were women.

"2. Physical examinations among the industrial establishments reporting were first introduced in 1900, but in the majority of cases they have been in operation only since 1914.

"3. Where physical examinations have been given a fair trial, they have proved their value and have been continued and, with one exception, the original scope of the examinations has been maintained or extended.

"4. The average time consumed in making regular physical examinations at establishments reporting was eight minutes per person examined.

"5. An earnest effort was being made in the majority of plants reporting to place defectives, rather than eliminate them from industry.

"6. The average percentage of rejected applicants for employment was only 4.6, and, by eliminating certain special cases, was only 2.8.

"7. There was no uniformity of time for reexamination of employees.

"8. Objections to physical examinations on the part of prospective or actual workers were negligible.

"This investigation shows that substantial progress has been made in the application of medicine to industry. The position of the physician in industry has been made secure, and he should now bend his efforts to the solution of industrial problems closely related to the medical work. By his training and experience he is qualified to advise with the management

as to the placing of employees to the best advantage of themselves and the industry with which they are connected. He is also in a position to suggest necessary improvements in the fields of lighting, ventilation and general sanitation, as well as of personal hygiene, in order that employees may be kept in good physical condition.

"A classification of the results of physical examinations is necessary in order that workers may be properly placed. The physical capacities and limitations of an A-1 worker and of a substandard worker should be fairly well defined. For example, only workers without physical defects should be placed in the A-1 class. This will be a relatively small group as compared with the vast majority of workers, who suffer from some slight physical or functional disability, but who are well able to carry on practically any work to which they may be assigned.

"A classification of findings of physical examinations which tends to place the worker in his proper group has been adopted and promulgated by the Conference Board of Physicians in Industry, after a careful analysis of a very large number of physical examination records. That such a classification is needed has been demonstrated by the analysis of the reports summarized above. This classification is as follows:

"Class 1: Persons physically fit for any employment.

"Class 2: Persons physically fit for any employment but below par in physical development or other condition.

"Class 3: Persons physically fit only for certain employment when specifically approved for it by examining physician.

"Class 4: Persons physically unfit for any employment.

"Knowing the requirements of the work which the applicant for employment is to do and having a record of his physical condition, the task of the industrial physician then becomes one of physically adapting the employee to his work, with the assurance that if this is done properly there will be greater contentment, lessened labor turnover, and greater production." — C. K. Drinker.

Industrial Clinics in General Hospitals. *W. Wright.* Mod. Hosp., Dec., 1920, 15, No. 6, 506–508. — The new industrial medicine tends to introduce new needs and broader conceptions into the medical sciences, especially in respect to diagnosis. Technical diagnosis must be supplemented by social diagnoses concerning influences in the patient's life which were, perhaps, as potent factors as an infection in causing the disease. It is not enough to find tuberculosis or lead poisoning: we should speak of tuberculosis plus malnutrition; or lead poisoning plus an ignorance of industrial hazards as causes of diseases.

It is the recognition of the importance of work as a factor in the ill health of an individual that has produced the branch of medicine now called industrial hygiene. General hospitals must adapt themselves to these new and larger requirements. There should be clinics or departments to which cases possibly related to industrial activity or to environment may be referred. The clinic can best be established in connection with the hospital dispensary, but this clinic should have the privilege of selecting its own material, because of the inability at the present time of most clinicians to recognize either specific industrial maladies or the common effects of industrial health hazards. The specialized industrial clinic can serve not only in making accurate diagnosis and offering efficient treatment, but also in observing the conditions of life and of employment which affect working people. Though specific industrial diseases are relatively few, the deleterious effects of many kinds of work are important and prevalent factors in disease, and it falls in part to the industrial clinic of the hospital to investigate these factors and to meet the conditions that they present. In industrial communities hospitals should provide resources for the treatment of industrial cases by the best methods, including industrial eye injuries and treatment of serious burns and fractures, as well as facilities for the restoration to function of impaired members. The cost of such hospital care should be borne in full by industrial commissions or designated insurance carriers, or should be shared by the employers of injured workers. — G. E. Partridge.

# ABSTRACT OF THE LITERATURE

## OF

# INDUSTRIAL HYGIENE

VOLUME III AUGUST, 1921 NUMBER 4

## CONTENTS



## GENERAL

HEALTH SERVICE ESTABLISHES FOOTING. *C. D. Selby.* Hosp. Management, Jan., 1921, 11, No. 1, 58. — A review of 1920 shows us the footing of industrial surgery and industrial medicine. The present status of the industrial physician has largely been brought about by compensation laws for injuries and industrial diseases. Although in the present business depression the industrial physician must stand aside for a while, there can be no doubt that employers will soon recognize the importance of industrial medicine. — Elinor D. Gregg.

THE APPLICATION OF STATISTICS TO THE STUDY OF EMPLOYMENT AND SICKNESS. *Thiele.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 35–38. — The author discusses the necessity, in the statistical study of industrial medical problems, for a practical and exact classification in order to make it clear which workmen are exposed to particular industrial hazards and which ones are otherwise connected with the industry in question. — E. L. Sevringhaus.

FISHERMEN'S DISEASES. *H. Muir Evans.* Notes and Comments, Lancet, March 5, 1921, 1, No. 10, 517–518. — The accidents described were those due chiefly to the dogfish, the sting ray and the greater and lesser weever. Dr. Evans said the most common injury was caused by the poisonous spine of the weevers, which possess a perfect double-grooved exploring needle on either gill cover. At the root of the spine is a definite poison gland. When alarmed, the fish erects its gill cover, bends itself round, driving the poisoned spine into any adjacent body, which at once receives some grumous drops of a highly poisonous nature.

There are smaller poison organs on each spine of the dorsal fin.

The burning pain that follows a sting is so severe that men will attempt to throw themselves overboard, or will hammer the affected part with a thole pin against the bulwarks. The pain lasts several hours and is accompanied by immediate swelling of the affected part. The limb may be partially paralyzed for a time. In a few hours the swelling subsides, or it may go on to phlegmonous inflammation with local gangrene around the site of the injury.

Dr. Evans finds that weever venom contains a neurotoxin, a hemolysin, and a leukotoxin. The hemolytic constituent differs, however, from most snake venoms, in that it acts directly on washed red corpuscles — that is to say, without the presence of serum. This statement, he affirms, conflicts with certain French workers, but he considers it is because they used filtered glycerine extracts, while his experiments were made with fresh poison. This fish venom markedly diminishes the phagocytic action of the leukocytes and thus secondary septic inflammation frequently follows a sting.

Regarding treatment, ammonia is popularly presumed to counteract the poison. In the islands of Mauritius and Réunion where a similar stinging fish, the synancia, frequently injures the feet of fishermen, the natives employ the leaves and seeds of a species of datura, and find they give relief. According to Bottard, the seeds of abrus precatorius, or jequirity, have the virtue of a specific. Applications of heated vinegar or the liver of the fish itself to the injured part are other remedies in use. Fish venom, just as snake venom, is destroyed by potassium permanganate, chloride of lime, and chloride of gold. Dr. Evans suggests that a "Lauder Brunton snake-bite lancet" be carried by all drifters and smacks so that a really efficient remedy may be at hand.

During the summer voyages the drift fishermen get their nets full of jelly-fish and the sting causes much burning pain followed next day by intense itching. The toxin contained in the tentacles is thalassine. After the summer fishing, while mending the nets, the men sometimes suffer so greatly from lachrymation and sneezing that this work has to be stopped. The author suggests that this trouble is caused by the toxin which clings to the strands and which, when dry, is liberated with the dust from the nets.

Boils, sometimes spreading to form large suppurating areas, are common on the forearms of fishermen during the autumn and winter. The rubbing by the edges of the "oilies," the sea water and dirt of the seafarers' calling are no doubt responsible. — R. Prosser White.

Joplin Zinc: Industrial Conditions in the World's Greatest Zinc Center. *C. M. Mills.* Survey, Feb. 5, 1921, 45, No. 19, 657–666. — The Joplin district occupies corners of Oklahoma, Missouri, and Kansas, comprises 1,000 square miles, and is the home of 12,000 miners. The territory is peculiarly barren and hideous in its outlook because of the ravages caused by mining. This seems to be a psychological factor in the life of both miner and operator. Peculiar features of the district are that 94 per cent. of the miners (in the leading towns) are American born of American parents, and that they are entirely unorganized.

The natural conditions of mining in the Joplin district are favorable but, from the standpoint of safety, the equipment and mode of operation are poor. The statutes of Oklahoma require that the operator shall provide every gear carriage used for the hoisting or lowering of persons with a sufficient overhead covering, and that at all shafts safety gates shall be placed. In visiting many mines, however, the author never saw an overhead covering on a can, nor any evidence of hoisting safety devices.

Comparison of mining accidents occurring in the Missouri part of the Joplin district with those of the Eastern Missouri district for the years 1914 to 1918 shows 24.8 fatal accidents per year in the Joplin district and 8 in the Eastern district per 1,000 three hundred-day workers; and, respectively, 14.3 and 7.4 nonfatal accidents. Fall of rocks is the greatest cause of accidents, and it can be said that these accidents are largely due to the carelessness of the miner and the operator. The system which allows miners, roofers, and drill men to work above shovelers, contributes to unnecessary accidents. The chief cause of accidents in mills is unguarded machinery. In no mills visited were there proper safety devices, and in some cases the conditions were very bad. The author recommends a safety program which would correct these conditions and which would include education through safety councils and committees, prohibition of "squib shots," and elimination of the hazards mentioned by obvious

remedies, such as the installation of well-known safety devices. The piece-rate system is also to be condemned as tending to exhaust the human factor in the industry, leading to the permanent injury of the workers and the ultimate disadvantage of the operator.

Joplin ore is brittle and produces a great quantity of dust. Silicosis or miners' consumption is, therefore, very prevalent in the district. After an investigation in 1915 state laws were passed in Missouri requiring the use of water lines for sprinkling, wash and change houses, and the closing of unsafe and unsanitary mines. The watercore drill has come into general use in the district and has brought about much improvement in the conditions. The silicosis problem still remains, however, and not very much progress has been made with it.

Individualism and freedom have produced irresponsibility in regard to sanitation and housing. The operators in the Joplin district have, with rare exceptions, done nothing for the welfare of their employees. The whole industry "stands in a pre-Victorian period of social development." The short-lived character of the average productive area, and the fact that the operators in this district are small capitalists and not large corporations, explain in part the conditions. The result is that the houses are poor, little is done to improve them, and less than half of them have adequate sanitary conditions. To a considerable extent the barrel system of water supply prevails — a fertile source of contagion, though the water is good.

The operators are responsible for these conditions and change must come through them. Production is carried on with little reference to outside conditions of the market, and the whole organization is to some extent unnatural. The economic development is, therefore, in the direction of centralization of operating interests and labor organization. There should be co-operation with the United States Public Health Service, enforcement of mining laws, a safety campaign, modification of the piece system, passage of health insurance laws covering silicosis, adoption of modern sanitary methods, adequate hospitals, co-operative housing associations, and community recreational centers. — G. E. Partridge.

Employment: Hours of Work. *W. Williams.* Ann. Rep. Chief Inspect. Factories and Workshops for the Year 1919. London, 1920, pp. 88–94. — From an industrial point of view a remarkable effect of the war has been the reduction in the hours of work, "which now rarely exceed an aggregate of forty-eight a week." The reduction has been made without legislation; it has occurred in almost all industries, and for the most part without serious friction between workers and employers. As regards the division of time, there is wide variation, even in the same district, but there are four prevailing systems: (1) the five-day week; (2) the single-break day (with only one long pause for meals); (3) the double-break day; (4) the shift system. The selection of the system has in many cases been left to the majority of the workers.

The reports indicate that the shortening of the hours has had a beneficial effect on the workers, "perhaps more so than any other recent improvement in industrial conditions." One result has been better "time-keeping"; reports are received that there is not only less sickness, but also less absence for general reasons, such as attending to home affairs. There is a difference of experience as to the effect upon production. When the production depends almost entirely upon the speed of machinery the output is said to be reduced nearly, or quite, in proportion to the hours. In cases where the production depends mainly or entirely upon the exertion of the workers, there is often said to be no decrease in production, and sometimes an increase is even found. On the other hand, there are instances in which the shortening of hours has in some way reduced the hourly rate of production. Changes in the method of work and in organization make a fair comparison of the output before and after the reduction difficult to some extent.

Even with the shorter hours, there still remains the difficulty of arranging sufficiently short periods of work to avoid diminished hourly output because of fatigue. Many firms have adopted the plan of having a short break in the work in the forenoon and another in the afternoon; and in general it has been found that these breaks result in increased production. In some districts there has been a lengthening of the mid-day interval, and there are various other provisions, such as special hours for married women and especially for mothers with babies. — G. E. Partridge.

A Manufacturer on the Short Day. *Henry H. Collins, Jr.* Survey, Dec. 4, 1920, 45, No. 10, 362. — Mr. Collins states that inas-

much as wages are fundamentally dependent upon unit production which also determines the cost of the manufactured article, the problem of the shorter working day is whether production per individual can be sufficiently maintained to make it possible to pay a living wage and sell the product at a reasonable price. England's experience cannot be used as the sole criterion for this country, nor can all industries be expected to react alike. The fact remains, however, that it is one of the problems of good management to ascertain the amount of fatigue which can readily be borne by the workers in each industry. We have the expedient of two or three shifts for plants working continuously.

In Mr. Collins' experience, a 3 per cent. reduction in production was more than compensated for by the spirit of contentment which it brought about among the workers. Rest periods of from ten to fifteen minutes in the mid-morning and mid-afternoon, and an afternoon lunch of crackers and milk contributed noticeably toward the diminution of accidents. — Elinor D. Gregg.

The Laboratory for Industrial Psychotechnics at the Technical Training-School in Charlottenburg. *W. Woede.* Deutsch. med. Wchnschr., Dec. 2, 1920, 46, No. 49, 1370. — A psychotechnical laboratory has been established in connection with the industrial training-school at Charlottenburg, where an attempt will be made to study the individual peculiarities of each pupil with regard to the type of occupation for which he will be most fitted, and also to study the psychological requirements of various industrial tasks, with a view to lightening them whenever possible. The co-operation of several factories, the railroads, and the post-office has also been secured for the study of industrial tasks outside of the school. — T. J. Putnam.

# SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

## CIRCULATORY SYSTEM

The Ambulatory Patient with Cardiac Disease, with Special Reference to Digitalis Therapy. *Emil J. Pellini.* Jour. Am. Med. Assn., March 19, 1921, 76, No. 12, 774–777. — The author gives his experiences with 250 cases followed in the cardiac clinic of the Bellevue Hospital, in New York. He is particularly interested in the use of digitalis with ambulatory patients who are not under the perfect control characteristic of hospital cases.

Patients are carefully examined with a view to estimating the condition of the cardiac muscle. If a patient is not perfectly compensated, he is given digitalis until a dosage is found which can be taken indefinitely without fear of overdigitalization. In doing this it should be remembered that there is more danger in too little digitalis than in too much. The final readjustment of the patient to his work takes place after he has been functionally classified and placed upon a definite régime of digitalis, and this readjustment is a matter for careful study in each patient. — C. K. Drinker.

The Equivalent of Ordinary Exertion. *May G. Wilson.* Jour. Am. Med. Assn., April 30, 1921, 76, No. 18, 1213–1214. — Patients with cardiac disease have been placed in the following classes by the Association of Cardiac Clinics in 1917:

"Class 1. — Patients with organic heart disease who have never had symptoms of cardiac insufficiency under ordinary conditions of activity.

"Class 2. — Patients with organic heart disease who have had such symptoms previously, but who do not have them at present under ordinary conditions of activity.

"Class 3. — Patients with organic heart disease who at the time of observation have symptoms of cardiac insufficiency following ordinary exertion.

"Class 4. — Patients with possible heart disease. Patients who have abnormal physical signs in the heart, but in whom the general picture or the character of the physical sign leads us to believe that it does not originate from cardiac disease.

"Class 5. — Patients with potential heart disease. Patients who do not have any suggestion of cardiac disease, but who are suffering from any infectious condition which may be accompanied by such disease; or who have suffered from such diseases: *e. g.*, rheumatic fever, tonsillitis, chorea, syphilis."

This classification depends throughout on what sort and amount of activity is considered

to be ordinary exertion. A table of test exercises — work with dumb bells and climbing stairs — is given which is considered to represent ordinary activity in children. Since the data furnished apply to individuals between 6 and 15 years, they are only of suggestive industrial significance and are not reviewed in detail. — C. K. Drinker.

Electrocardiography and its Significance in Insurance Medicine. *H. Sachs.* Zentralbl. f. Gewerbehyg., Jan., 1921, 9, No. 1, 8–11. — An elementary discussion of cardiac rhythm and conduction, the use of the string galvanometer, the use of the electrocardiogram in diagnosis, followed by the statement that the method should help in insurance work to decide doubtful cases and to demonstrate the harmless character of certain cases of arhythmia. — E. L. Sevringhaus.

### NEUROMUSCULAR SYSTEM

New Occupational Pain; Case of Chorea. *J. J. Moren.* Abstracted as follows from Kentucky Med. Jour., Feb., 1921, 19, No. 2, 43, in Jour. Am. Med. Assn., March 19, 1921, 76, No. 12, 820. — "Moren relates the case of a man, aged 48, a railroad mechanic who during January, 1920, began to complain of pain in his right elbow; in May the left elbow became involved. He has had all kinds of treatment without relief. He suffers a great deal of pain after he quits work. There is practically no pain on extension. The pain sometimes radiates up and down the arm. No particular portion is affected more than another. Contraction of the muscles by the electric current produces the same pain as on voluntary flexion of the elbow. Physical examination was negative. On making inquiries as to occupation it was found that he was handling a compressed air motor drilling holes in various pieces of machinery. His position in the use of this motor was one of flexion of the arm, lifting the weight and at the same time holding it in position, and was accompanied by more or less vibration. Rest gave relief." C. K. Drinker.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Medical Decisions on Cases of Industrial Poisoning. *F. Curschmann.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 38–44. — Two cases are discussed and declared to be instances of septic thrombus in the brain and of local arteriosclerosis in the foot rather than of poisoning with acetylene or with the liquid and fumes from the "Clark" apparatus as was alleged by the victims. In neither case had the physician in charge doubted that his patient was suffering from industrial poison. — E. L. Sevringhaus.

Foundry Fever. *E. Rost.* Abstracted as follows from Arb. Reichsgesundh., 1920, Vol. 52, pp. 1–4, by H. V. Atkinson, in Chem. Abstr., April 10, 1921, 15, No. 7, 1037. — "Experiments on animals and men indicate that Zn vapors in foundry gas are the cause of foundry fever. Zn was found in the urine and feces of workers. Foundry fever may be prevented by better ventilation."

Chronic Carbon Monoxid Poisoning — Its Immediate and Subsequent Manifestations. *Georgine Luden.* Mod. Med., Feb., 1921, 3, No. 2, 102–106. — This article deals with the personal experiences of the author and of her friend. For several months they suffered a wide variety of symptoms. Qualitative tests for carbon-monoxide hemoglobin were found positive. The number of tests is not stated. The symptoms were attributed by the author to poisoning by furnace gas. The belief is expressed that chronic carbon monoxide poisoning is very frequent and serious; that the endocrine glands are involved, and that a "hypersensitization" occurs. No convincing proof of these assertions is brought forward, however. — H. S. Forbes.

Chronic Carbon Monoxid Poisoning — Its Immediate and Subsequent Manifestations. *Georgine Luden.* Mod. Med., March, 1921, 3, No. 3, 167–170. — This article describes in detail a great variety of symptoms attributed to inhalation of carbon monoxide in furnace gas. The observations are based chiefly upon subjective symptoms noted by the author and a friend living in the same house, and upon certain objective signs.

Mention is made of one qualitative test for carbon monoxide hemoglobin which was positive in three inmates of the house. No gas analyses of the air in the house are given. The assertion is made that the gas clings tena-

ciously to clothing, etc.; the evidence brought forward in support of this is based upon symptoms noted by the author in herself and in her friends. The belief is expressed that a relation exists between chronic carbon monoxide poisoning and disorders of the endocrine glands, and the chief basis for this opinion seems to be analogy of symptoms. In conclusion, the author finds a "relation between slight chronic carbon monoxide poisoning and many hygienic, social and domestic problems." — H. S. Forbes.

Industrial Poisoning with Hydrocyanic Acid Gas in Gold and Silver Plating. *Holtzmann.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 44–45. — A résumé of the technical processes in the gold and silver plating industries explains the ways in which a slow but continuous evolution of hydrocyanic acid fumes may occur. Ventilation is sufficient to remove all danger. Only part of those exposed suffer any symptoms. Acute manifestations are conjunctival irritation, sweet taste, and headache. Some suffer from eczema. Many physicians refer a chlorosis among the women to a chronic poisoning by this gas. — E. L. Sevringhaus.

Poisoning from Wearing Dyed Shoes. *F. Neuhoff.* Abstracted as follows from Mo. State Med. Assn. Jour., Feb., 1921, 18, No. 2, 53, in Jour. Am. Med. Assn., March 19, 1921, 76, No. 12, 820. — "Five, and again three, hours before becoming ill Neuhoff's patient had dyed his shoes while wearing them. The dye was found to contain a large amount of nitrobenzol, an intermediate product formed in the manufacture of anilin from benzene. Taken internally, seven drops have caused death. It is also poisonous when inhaled or applied to the skin. It is used in the manufacture of explosives and anilin derivatives. Workmen who inhale too much of it, or spill it on themselves, are poisoned by it, death even at times resulting. The symptoms of poisoning come on several hours after the application of the poison to the skin and are favored by perspiration. They are cyanosis, anxiety, vomiting, formication, ringing in the ears, disturbed co-ordination, low blood pressure. The blood becomes a brownish color. In fatal cases there may be jaundice, convulsions, and coma preceding death. The treatment recommended is blood letting, artificial respiration, inhalation of oxygen, and stimulants, but no alcohol." — C. K. Drinker.

Cancer of the Bladder among Workers in Aniline Factories. Internat. Labour Office, Studies and Reports, Series F, No. 1, Feb. 23, 1921, pp. 26. — "Although it is not possible at present to formulate definite conclusions, inasmuch as the problem still presents too many lacunae and obscure points, it may, nevertheless, be said that:

"(1) There is a close connection between the manipulation of certain amino-compound products and the existence of tumours of the bladder.

"(2) The number of cases of tumour of the bladder proved to have occurred among workers in contact with amino-compounds is certainly small. It must be concluded from this that the individual factor plays a great part in the pathology of the disease, seeing that the patients constitute a small minority.

"(3) Action of long duration is necessary to produce tumours of the bladder. There is no relation, however, between their occurrence and the duration of employment.

"(4) It is not possible to determine the substance capable of engendering tumours. At present one can go no further than to incriminate the amino-compounds, and particularly benzidine and beta-naphthylamine.

"(5) The same substance may produce either simple cystitis, or benignant or malignant tumours.

"(6) Hygienic precautions, strictly applied, will assure at the end of a few years the diminution and even the disappearance of the disease.

"(7) It is, therefore, absolutely necessary that in factories in which workers are exposed to the dangerous action of aromatic bases, the most rigorous application of hygienic precautions should be required.

"(8) Meanwhile, it is desirable that the industries concerned should continue to carry on researches with a view to ascertaining the dangerous substance, and that the statistical particulars in every case should be very precise and should follow the proposed questionnaire." — M. C. Shorley.

Intoxication with Fluorine Compounds. *Kockel* and *Zimmermann.* Abstracted as follows from München. med. Wchnschr., 1920, Vol. 67, pp. 777–779, by S. Amberg, in Chem. Abstr., March 10, 1921, 15, No. 5, 705. — "Two cases of fatal F poisoning are reported, one due to a rat poison, 'Orwin,' containing NaF, the second a case of murder. The course of the in-

toxication does not show anything pathognomonic for F. To demonstrate the F, the organs were boiled with water, the filtrate evaporated, the residue treated with $H_2SO_4$, heated and the vapors were tested in the usual way for their power to etch glass. The stomach and its contents as well as the small intestines gave a positive test. Liver, kidneys, spleen and blood did not."

The Early Diagnosis of Lead Poisoning. *J. Schoenfeld*. Zentralbl. f. Gewerbehyg., Jan., 1921, 9, No. 1, 3–7. — Symptoms have not always been sufficient for an early diagnosis of lead poisoning. The stippling of the red blood cells is the best guide to diagnosis and to the progress of recovery. The author has seen from 30 to 15,000 stippled cells per million. He considers 100 per million as a positive diagnosis. The stippled cells disappear when the severe symptoms, such as nephritis or paralysis, occur. Stippled cells gradually disappear under treatment in the course of weeks to months, the hemoglobin increasing simultaneously.

Women appear more susceptible to lead than men. Since 1913 the number of cases of lead poisoning and the loss of laboring time have markedly decreased, as prophesied by the author at that time. He believes this is due fundamentally to early diagnosis being made by blood examination. A further reduction in incidence is to be looked for from the development of a sense of individual responsibility in the workers. — E. L. Sevringhaus.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Occupational Dermatitis in Dentists: Susceptibility to Procain. *C. Guy Lane*. Arch. Dermat. and Syph., March, 1921, 3, No. 3, 235–244. — Dr. Lane reports three case histories of dermatitis caused by the use of procain, a cocain substitute employed extensively by the dental profession and which has several technical advantages over cocain. The symptoms shown were redness, swelling, severe itching and fissures, with scaliness. The skin tests showed uniform reactions. The evidence offered is debatable ground but indicates an individual susceptibility rather than sensitization by constant handling. There are recorded three cases of death after the use of procain. It is unusual but possible for poison to enter through the normal integument. The cases reported all cleared with protection by rubber gloves but relapsed when that care was discontinued. — Elinor D. Gregg.

Dermatitis Due to Carpoglyphus Passularum. *W. J. O'Donovan*. Abstracted as follows from Brit. Jour. Dermat. and Syph., 1920, Vol. 32, p. 297, by Senear, in Arch. Dermat. and Syph., March, 1921, 3, No. 3, 299. — "O'Donovan reports the case of a man who, while shoveling dried figs, developed over the forearms, backs of the hands and on the face an eruption of discrete, closely set, apparently follicular papules, pale pink in color with red scabbed tops. The lesions were suggestive of scabies, but were too small, and there was no evidence of burrowing.

"Examination of the figs showed them to be covered with a fine, light brown powder, which microscopic examination disclosed was made up of live and dead mites and numerous fragmented particles of acari and their limbs. The parasite was identified as *Carpoglyphus passularum*. The author states that Rasch had previously described two cases of dermatitis due to the Carpoglyphus occurring among workers who had been handling dried plums." — M. Dent.

Visual Fatigue. *E. Jackson*. Abstracted as follows from Am. Jour. Ophth., Feb., 1921, 4, No. 2, 119, in Jour. Am. Med. Assn., March 19, 1921, 76, No. 12, 817. — "Some analysis of different forms of visual fatigue, and attempt to localize the essential change that gives rise to fatigue, and a recognition of the extremely important part that efforts of co-ordination play in producing fatigue, Jackson believes ought to be useful in giving a better conception of a condition that passes easily from physiologic to pathologic significance. It should, he says, be borne in mind that normal visual fatigue rarely rises into consciousness. Only when the organism in response to long continued or repeated excessive fatigue has developed a method of translating this into discomfort or pain does it develop into symptoms." — C. K. Drinker.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Inadequacy of Industrial Accident Statistics Published in State Reports. *Margaret Gadsby.* U. S. Bur. Labor Statis., Month. Labor Rev., March, 1921, 12, No. 3, 167–176. — The author very strikingly illustrates her subject and contention by a series of state reports for the years 1917, 1918, and 1919. —R. B. Crain.

The Obscure but Most Prolific Hazard. *H. W. Mowery.* Safety Engin., April, 1921, 41, No. 4, 183–184. — Two charts picture the causes of accidents. In the first of these, 23.5 per cent. of the accidents from seventeen different causes were due to falls. The second shows the high percentage of falls which occur on the level ground — 23.4 per cent. of all falls from ten different causes. Slipping hazards should be sought out and eradicated; various anti-slip treads help. — M. Dent.

Who is to Blame for Accidents? Nat. Safety News, Feb. 28, 1921, 3, No. 9, 3, 10. — A study of the accidents that have occurred in the plants of the Nicetown Works of the Midvale Steel and Ordnance Company during a period of ten years led to the conclusion that the responsibility is divided as follows: accidents in which the injured individual is responsible constitute about 60 per cent. of the cases; accidents which are "nobody's fault" (most of them trivial) make about 30 per cent.; those for which a fellow workman is to blame make a little less than 10 per cent., and accidents for which the company is responsible constitute less than one-half of 1 per cent.

Accidents that are nobody's fault include those which arise out of the occupational hazards more or less incidental to the employment and they are usually non-preventable. Accidents for which the company is responsible are such as those occurring where sufficient light or the proper tool has not been provided, or the proper safety device installed. The content of the remaining classes is varied — workmen are responsible when they operate a machine without permission, neglect to wear goggles, violate various rules, select improper methods of work, etc. Carelessness in handling materials, scuffling, etc., are examples of the causes of accidents to others. — G. E. Partridge.

United States Steel Corporation Analyzes Causes of 200,000 Accidents. Nat. Safety News, Feb. 7, 1921, 3, No. 6, 3–4. — A recent bulletin of the Bureau of Safety, Sanitation and Welfare of the United States Steel Corporation contains a chart analysis of 220,707 accidents that have occurred in the plants of the corporation. Hand labor is reported as responsible for 44.47 per cent. of all the accidents, and machinery for 4.94 per cent. The remaining 50 per cent. are somewhat obscurely classified as follows: mines, 14.76 per cent.; falls, 8.09 per cent.; burns, 7.13 per cent.; eyes, 5.10 per cent.; railroads, 4.26 per cent.; all others, 11.30 per cent. The conditions under which nearly half of the accidents occur are almost entirely within the control of the workmen and the accidents are due largely to their carelessness or thoughtlessness. In addition to these hand labor accidents, there are hundreds of accidents in which the fault of the employees was a contributing cause; in carefully analyzing the causes of any 100 accidents, it will be found that at least 90 per cent. of them might have been prevented, if a little more care had been taken. The guarding of machinery is necessary, but it is not such an important part of the work of prevention as is sometimes supposed.

The report also contains figures in regard to the amount of money expended by the company in safety work, the number of men trained in first aid, and the number of articles and devices provided for the comfort and welfare of its employees. — G. E. Partridge.

Quarry Accidents in the United States during the Calendar Year 1919. *W. W. Adams.* U. S. Bur. Mines, Tech. Paper 275, 1921, pp. 66. — A series of tables based on reports received from operators of quarries, and which, therefore, present all stages of the industry, and are representative of the entire industry. — M. Dent.

Coal Mining Accidents in the State of Washington. Safety Engin., Feb., 1921, 41, No. 2, 62–64. — This paper contains a summary of educational provisions in effect January 1, 1920, the decrease in frequency, and increase in severity, of accidents; and a comparison of coal mine fatalities in the principal coal producing countries for a period from 1901 to 1911. — M. Dent.

Rules for Prevention of Gas Explosions in Anthracite Mines. *J. J. Walsh.* Safety Engin., Feb., 1921, 41, No. 2, 69–72. — The casualties as a result of gas explosions in

the anthracite mines of Pennsylvania during the past forty-seven years were one every working day, the ratio being one fatal to three non-fatal. Rules are given for the installation and driving of ventilating fans, building of stoppings, analysis of air, the avoidance of the use of main doors as far as possible, as well as rules requiring that special care be taken of sections where 125 cubic feet or more of methane is generated. — M. Dent.

The Status of Labor Union Accident Prevention. *F. Rothe.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 46–48. — In this categorical reply to an article which appeared under the same title in *Zentralblatt* for Sept., 1920, the emphasis is placed on the need for specialists in accident prevention and on the fact that the real aim of the work is the reduction of dangers rather than the multiplication of safety devices. — E. L. Sevringhaus.

Closing Devices for Carboys. Safety Engin., April, 1921, 41, No. 4, 188. — Frequent fires and accidents occur due to the leakage from, or breakage of, carboys used in transporting acids and other dangerous materials, which were until recently generally closed by a loosely fitting earthenware stopper held in place by clay, plaster of Paris, or burlap.

Work is being carried on by the Bureau of Explosives for the venting of acid carboys in order to prevent internal pressure, and for the development of porous stoppers which will permit the escape of vapors produced in transit and thus prevent accumulation of pressure. — M. Dent.

Wooden Machine Guards. *F. S. Benedict.* Safety Engin., April, 1921, 41, No. 4, 176. — The first efforts directed toward safeguarding are almost invariably made with wooden guards, cheapness being the appeal most readily listened to. There are thousands of wooden overhead belt guards which would be utterly useless in case the belt broke. These wooden guards accumulate dust and disease germs; become saturated with oil, and thus develop into a fire menace; act as flues if fire should start below; and splinter easily, thus causing small injuries which may become infected. — M. Dent.

Dispensary on Construction Jobs. *Herbert L. Davis* and *Thomas H. George.* Hosp. Management, Jan., 1921, 11, No. 1, 60. — The Thompson Starrett Company of New York believes in the well-worn cry of "Safety First." Somebody has been able to put life into the phrase and a spin into the company's safety program. Co-operation exists. Accidents are cared for — even the trivial ones. There are no cripples and very little lost time. Most amazing is the record of infections — only fourteen out of 820 accidents and none serious. Safety bulletins on the early treatment of scratches and puncture wounds are posted conspicuously. — Elinor D. Gregg.

What Pennsylvania is Doing for Safety and Safety Codes. *C. B. Connelley.* Bull. Penn. State Dept. Labor and Industry, 1920, 7, No. 7, pp. 20. — The safety program of Pennsylvania is based upon: (1) the enforcement of at least twenty-five specific acts of legislature, among them the acts creating the Department of Labor and Industry and the Workmen's Compensation and Rehabilitation Acts; (2) the placing of the responsibility for compliance with the requirements of thirty safety standards upon employers as well as employees; (3) serving the employees, the state officials and manufacturers with a means of knowing and approving appliances which are safe — the approved devices numbering 160 and classified as: (*a*) boiler appliances, (*b*) elevator appliances, (*c*) mechanical appliances, (*d*) electrical appliances, (*e*) motion picture appliances, (*f*) fire prevention and protection appliances, and (*g*) miscellaneous safeguards and appliances such as anti-slip treads, no-slip ladder shoes, ladders, etc.; (4) educational campaigns such as the Safety Congress and community-wide safety programs, motion picture entertainments, vocational clinics and the publication of bulletins, posters and pamphlets; (5) co-operation with the Department of Public Education in the instruction of "Safety First" in the public schools.

The history of the safety movement in the state is sketched for four periods: the pioneer period, the compensation period, the war period, and the re-adjustment or reconstruction period.

Part II of the report discusses the making of a safety standard — a standard requiring the co-operation of the worker, the employer, the engineer or technical expert, the manufacturer, the state, the insurance carrier, and the public.

In addition to the revision of all its codes the Pennsylvania Department is formulating new

codes for head and eye protection, sanitation, laundries, housing, and refrigeration. — G. E. Partridge.

Saving Men and Money at the duPont Plants. *L. Resnick.* Nat. Safety News, Feb. 21, 1921, 3, No. 8, 3–8, 14. — The most modern school of safety men has taken the position that every accident is a symptom of inefficiency. The nature of the business of the duPont Company in its early days made it quick to recognize this principle. But the greatest accomplishment of this company has been achieved since 1917, when the executives in charge of production "came to a clearer realization that all production men must be directly charged with responsibility for safety and health work." The result has been the reduction of the "fatal frequency rate per 1,000–3,000 hour men" from 3.20 in 1916 to 1.49 in 1920, and one department especially is to be noticed for having passed the year 1920 without a lost-time accident, although it is devoted to experimental work involving a great number of hazards.

The occupational disease problem of the duPont Dye Works, on account of the operations and the materials handled, is as important as that of accident prevention. An initial examination is made, and re-examination is required of many men each month in order to detect the first traces of occupational disease. As a result, there has not been a death from occupational disease since the dye works began operations three years ago. In one building, where trouble had occurred on account of poisoning from aromatic nitro-compounds, the wooden platforms and the wooden boxes, which had become saturated and were giving off fumes, were replaced by steel gratings and galvanized iron, and a special fume exhaust was installed for each container, the contents of which were under process of liquefaction by steam. Extreme care was given to personal cleanliness and to the cleanliness of the building, and as a result there was a marked reduction in the cases of poisoning and an increase in production. Other improvements in processes were made, such as replacing a filtrose-bed for pelleting material with a pelleting machine.

The methods employed to stimulate interest in safety work take into consideration characteristics of group consciousness. Departments are put into competition with one another, and sometimes groups within departments. Records are kept of "days without accidents," and the results are displayed on bulletin boards about the plants. Appeal to the sporting blood of the workers has proved a very effective way of reducing the accident rate.

The Safety Section of the duPont plant is divided into three branches: construction and design; manufacturing; and accidents and injuries. To the first division there falls the standardizing of safeguards and the checking of designs for new structures, etc. The manufacturing division superintends all the safety work of the manufacturing operations, and visits, inspects and standardizes educational activities. The third branch keeps records, prepares statistics, and attends to matters pertaining to compensation and the like.

Engineering revision, rather than afterthought machine-guarding, is a fundamental principle of the safety work of the company; and on the lines adopted good results have been obtained in reducing accidents and diseases. "Even the explosion hazard yields . . . to treatment by engineering revision, safety education, and proper supervision." — G. E. Partridge.

How to Induce Workmen to Come to the Shop Hospital. *C. F. N. Schram.* Nat. Safety News, Feb. 14, 1921, 3, No. 6, 7, 10. — Since accidents cannot be wholly prevented, it is important that there be provision for caring for injuries, and it is essential that all accidents, even very minor ones, be reported for treatment. The plan adopted at the Fairbanks, Morse and Company plant at Beloit, Wisconsin, includes monthly statements to departments of the records of all departments in respect to delayed reports. Lists of lost-time accidents are also sent out. In case a lost-time accident is one in which there was a delayed report, special attention is called to this fact. Another valuable aid to efficient service of the medical department is the proper attitude toward injured men — such considerate treatment as will cause men to go promptly for treatment. The "department monthly expense exhibit," in the form of a bulletin, helps to make department heads interested and careful. A good annual report regarding the safety and the hospital departments is valuable. Finally, every plant employing over 500 men (and some employing less) should have a trained nurse and a hospital department — not simply a first-aid station.

"No statement regarding the early reporting of injuries would be complete if it did not take into account the educational work done by the National Safety Council through its bulletins. It keeps the hospital department, the safety department, the superintendent, the foreman and the workman continually reminded that accidents are generally unnecessary, but that, when they do happen, proper care is essential." — G. E. Partridge.

## INDUSTRIAL SURGERY

Ambulance and First Aid. *J. C. Bridge.* Ann. Rep. Chief Inspect. Factories and Workshops for the Year 1919, London, 1920, pp. 83-87. — This report is mainly of local interest, since it consists principally of tables showing the extent to which the factory regulations, etc., in regard to first-aid and ambulance room service have been complied with in the United Kingdom. There are a few points of general interest. In respect to first-aid boxes, the most noticeable irregularity is in the lack of sterilized dressings. When the boxes are installed they are properly equipped, but when dressings are replaced, unsterilized dressings are apt to be obtained, and it is also reported that the sterilized dressings that are on the market are clumsy, and that there are not enough shapes and sizes to suit all cases. There is some objection made to the habit of dealers of supplying in the boxes articles not required (lint, bandages, iglodine, iodine solution, etc.). The objection is made on the ground that in this way beginners do not become fixed in the habit of using the sterilized dressings, although it is admitted that the iodine solution and the bandages may be allowable. Another complaint is that, despite printed instructions to the contrary, there is still a good deal of washing of wounds. One inspector thinks that it would be better if the directions omitted the negative caution, "do not wash," and merely explained how to clean wounds with iodine.

Progress is reported in the provision of ambulance rooms, and there is some discussion of the effect of the installation of the ambulance room upon the first-aid treatment in the shop, emphasizing especially the value of the immediate use of the sterilized dressings. It is suggested that the better keeping of records of accidents is having a good effect in focusing attention on the causes, and that, as regards first-aid training, the necessity is for more education in the use of the sterilized dressing; and it is urged that this treatment should be taught universally in first-aid classes. — G. E. Partridge.

Injuries of the Feet. *U. V. Portmann* and *F. C. Warnshuis.* Jour. Am. Med. Assn., April 30, 1921, 76, No. 18, 1214-1216. — A general review of the subject summarized by the authors as follows:

"One might continue at length to cite numerous case histories illustrative of the extent and character of foot injuries that we have been accustomed to classify as minor but which have produced great disability with some degree of permanence. It is our purpose here, not to develop an exhaustive treatise but to stimulate a better plan of treatment of foot injuries based on a better conception of physiologic functioning and reaction. We therefore draw attention to certain facts:

"1. The structure of the foot is complex, and there is a difference in the reaction of the tissues.

"2. Injury to an integral part has a large incapacitating influence on the whole member and the individual.

"3. The integral part affected must be accurately determined, and roentgenograms made a routine procedure in examination.

"4. The site of injury should not be treated exclusively. The whole part and its anatomic and physiologic relationship should be considered.

"5. Rest in elevation should be instituted at the beginning of treatment.

"6. Improper hot bathing is more productive of harm than of benefit.

"7. We are always dealing with infected areas.

"8. Incisions should be made at sites of election, never on plantar surfaces, and all wounds must be carefully debrided and coapted.

"9. Anatomically correct adjustment of footwear merits greater attention and frequently accomplishes the complete eradication of the final results of traumatism." — C. K. Drinker.

Diagnosis and Treatment of Disabilities of the Back. *James Warren Sever.* Mod.

Med., Feb., 1921, 3, No. 2, 98–102. — Besides the traumatic injuries to the back which are a result of industrial accidents, there are three common types of disability — namely, those due to the poor posture or static backache, which is produced by sitting or standing, inequality in the length of the legs, sacro-iliac strain, and spondylolisthesis or a slipping forward of the body of the fifth lumbar vertebra; those due to pelvic disease or abnormality in women, and which are invariably confined to the sacral or very low lumbar regions and comprise chiefly lacerations, retroversions, prolapse, etc.; and those resulting from diseases such as arthritis, tuberculosis, osteomyelitis, etc., of the vertebrae.

Back injuries due to industrial accidents result from: (1) strain from lifting, when the back seems to "snap" suddenly—in these cases it is difficult to differentiate between muscular and ligamentous tears, but the author believes that ligamentous tears are of longer duration, and that the soreness and tenderness are deeper seated; (2) crush fractures — a very general type of injury, in which the lesions are most commonly located at or about the dorsolumbar junction; (3) compressed fractures, which are most frequently caused by falls on the buttocks, shoulder or back, or from landing on the feet from a great height; (4) contusions, which usually follow a blow or a fall, and in which the resultant injury is generally to the soft part, although deeper bony structures may be injured; (5) fractures of the vertebral bodies. These are especially interesting because the patient only complains of a stiff or lame back, and some tenderness over the site of the injury. Very few have symptoms due to nerve pressure, probably owing to the fact that the spinal cord ends at about the level of the first lumbar vertebra, the point of greatest frequency of fracture. The treatment should be early and adequate fixation of the spine in a plaster jacket and, subsequently, by a brace. An X-ray is always essential. Common complications are sciatica, hypertrophic arthritis, generally quiescent and pre-existent to the injury. — Elinor D. Gregg.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Quantitative Distribution of Particulate Material (Manganese Dioxide) Administered Intravenously to the Cat. *Cecil K. Drinker* and *Louis A. Shaw*. Jour. Exper. Med., Jan. 1, 1921, 33, No. 1, 77–98. — As the result of a most instructive series of experiments the authors draw the following conclusions:

"1. Manganese dioxide suspended in an acacia-sodium chloride solution provides a non-toxic injection which in the present experiments has contained no particles larger than 1 $\mu$ and which, when deposited in the body, can be determined quantitatively and seen microscopically.

"2. Intravenous injections have been made under precautions which preclude removal from the blood or deposition in organs through simple capillary blockage.

"3. In nine experiments out of thirteen the circulating blood contained no manganese after 18 minutes. In the four remaining instances there was a slight elimination which was incomplete at the end of 1 hour. Within certain limits the rate of removal from the circulating blood and the sites of deposition in the animal are not influenced by the concentration of the suspension, the blood pressure, or antecedent introduction of acacia or histamine.

"4. In the cat amounts of manganese dioxide varying between 9.8 and 3.9 mg. of manganese and containing from 50,000,000,000 to 10,000,000,000 particles, if injected intravenously, permit recovery at the end of 1 hour of 90 per cent. of the material in the lungs, liver, and spleen in the following proportions: lungs 47 per cent.; liver 38.3 per cent.; spleen 4.3 per cent.

"5. These experiments, coupled with correlative results by other investigators, make it clear that in certain organs — the lungs, liver, and spleen of the cat — the vascular endothelium possesses phagocytic power rendering the capillaries permeable to particulate material as well as to gases, liquids, and dissolved substances." — H. F. Smyth.

Shop Standards and Fatigue. *Bernard J. Newman*. Mod. Med., Feb., 1921, 3, No. 2, 93–97. — Sufficient progress has been made in dis-

covering the cause of industrial over-fatigue to warrant the introduction of plant programs for its control. The economic losses from fatigue are estimated at 20 cents per worker per day per year. On this basis, with the normal working year of three hundred days, the monetary loss to the nation amounts to $2,400,000,000 — a very appalling figure.

Fatigue is caused by the muscle waste produced by metabolism; its usual manifestations are loss of appetite, anemia, digestive derangements, respiratory and cardiac affections, fatigue neuroses and neurasthenia, and weakened power of resistance to bacteria. Industrial fatigue is caused directly by continuous lifting, long standing, cramped positions, the continuous use of the same set of muscles, sitting in faulty postures, excessive noise, high temperature and humidity, extremes of heat and cold, and light intensity; the indirect causes may be said to be dust-producing work, inadequate and insanitary drinking facilities, no rest rooms, unsympathetic management, unattractive workrooms, congestion of workrooms, no industrial hygiene nor provisions for medical and surgical relief.

The tests for industrial fatigue are divided into the four following groups: (1) laboratory tests touching physiological, chemical, and bacteriological reactions to labor causing over-fatigue; (2) factory tests in regard to production — spoiled work and accidents are also important indices of fatigue; (3) physical tests upon employees to determine their capacity for arduous labor; and (4) a miscellaneous group including all tests of other character.

The fundamentals of a plant program for reducing fatigue are: (1) physical examination of applicants and periodic re-examination; (2) physical examination of the jobs to find out their requirements, mentally and muscularly; (3) physical examination of the plant to discover the working conditions which may injure the health of the worker, increase fatigue and reduce output. — Elinor D. Gregg.

The Influence of Dilution on the Toxic Action of Alcoholic Liquids. *H. M. Vernon.* Brit. Jour. Inebriety, Oct., 1920, 18, No. 2, 39–76. — The author's summary is as follows: "A series of fifty-seven experiments was made in which alcoholic liquids containing 15 to 90 c.c. of alcohol were taken three and a half hours after food, or on an empty stomach. A memorized passage was typed at twenty minute intervals before and after the alcohol, and it was found that the typing mistakes were invariably increased, and the typing time almost invariably. For each extra mistake the typing time was increased, on an average, by about two seconds above its pre-alcohol value of ninety-eight seconds, and the alcohol acted synchronously on time and on mistakes; but in order to reduce the results to terms of a single variable, the mistakes made were corrected throughout to a constant typing speed.

"It was found that when taken in the form of whisky of 20 per cent. alcoholic strength (by volume), 18.3 c.c. of alcohol caused an increase of 0.8 in the number of corrected mistakes, 30 c.c. alcohol one of 3.4, 45 c.c. one of 8.0, and 60 c.c. one of 17.0, or the effect increased at a more and more rapid rate the greater the quantity of alcohol taken. With 5 per cent. whisky the effects produced were considerably smaller, and 75 c.c. alcohol taken in this form had the same effect as 57 c.c. alcohol in the form of 20 per cent. whisky. Beer of 5 per cent. alcoholic strength produced 20 per cent. more mistakes than whisky of the same strength, but 4 per cent. beer was much less toxic, and 90 c.c. alcohol in this form produced only as much effect as 68 c.c. alcohol in the form of 5 per cent. beer.

"The toxic effect of 3 per cent. beer and 3 per cent. cider was much slighter than could have been anticipated, and 90 c.c. alcohol in the form of 3 per cent. beer produced only as much effect as 54 c.c. in the form of 4 per cent. beer, as 46 c.c. in the form of 5 per cent. beer, and as 42 c.c. in the form of 20 per cent. whisky. The 90 c.c. of alcohol mentioned is contained in $5\frac{1}{4}$ pints of the beer, and it was calculated that in my own case 10 pints would be needed in order to induce a condition of intoxication, and that it would take over four hours to drink it. In that I am more susceptible to alcohol than the average man, it may be said that, *practically speaking, beer containing 3 per cent. by volume of alcohol, or 5.25 per cent. of proof spirit, is a non-intoxicating liquid.*

"It appears that the alcohol in 5 per cent. whisky and 5 per cent. beer is absorbed rather *faster* than that in 20 per cent. whisky, though the simultaneous absorption of a greater volume of water reduces the toxic effect produced. Concentrated alcoholic liquids exert such a paralytic effect on absorption that the effects produced by 45 c.c. alcohol were practically the same, whether this was taken as whisky of

48.5 per cent., 20 per cent., or 10 per cent. concentration. Again, it makes very little difference whether the whisky is drunk in a minute or spread over half an hour.

"Beer differs from whisky in that it has a relatively greater effect on the typing time and a relatively less effect on the typing mistakes. Claret has nearly the same effect as whisky of equal alcoholic strength." — C. K. Drinker.

The Application of Certain Physical Efficiency Tests. *Verner T. Scott.* Jour. Am. Med. Assn., March 12, 1921, 76, No. 11, 705–707. — Schneider, in May, 1920, gave an account of a method for physical efficiency rating used in the air service. The plan utilized variations in pulse rate and blood pressure under simple conditions and resulted in a point score for each individual examined, 18 being the highest rating attainable. Crampton in 1915 proposed a somewhat similar but less complicated test.

Scott has compared both systems and finds Crampton's less adequate, since it does not cover all the necessary physiological elements. To gain the details of both methods of testing, the reader must consult the original papers by Schneider and Crampton, to which references are given in Scott's article.

On the basis of 410 cases to which Schneider's test was applied Scott gives the following summary:

"Schneider's test does not supplant, but should be used in conjunction with, a thorough physical examination. For use with aviators and athletes, this is the best test so far offered for measuring physical efficiency and fatigue.

"The practitioner of preventive medicine, and physical directors of schools and colleges, will find this test a valuable aid in determining the amount of exercise necessary for physical fitness in each individual case. There may be overtraining and undertraining of an individual. Although we find that a score of 7 or less is an indication of improper functioning of the neurocirculatory apparatus, we believe that a man who can only make a score of 9 should be given a thorough physical examination to determine whether his condition is due to disease or to insufficient exercise.

"The conditions that we find that lower the index are aviation fatigue, loss of sleep, lack of physical exercise, alcoholic and sexual excesses, and acute infections.

"We have encountered two conditions in which this test or any other test based on pulse rate will not reveal the true condition of the man. Bradycardia on account of the low pulse rate gives a better rating than the condition warrants, and those who are disturbed psychically by a physical examination will get a lower rating than they deserve on account of high pulse rate. But the latter condition can be allayed by a tactful nurse or physician.

"The index gives the true condition at the time of the test. When it comes to qualifying or disqualifying an aviator for flying, or to determining the amount of exercise needed by an athlete, it is best to determine the index on three successive days. If the man has not lost sleep or dissipated, his index will not vary more than 1 point. The reason for not relying on one index is that one may be getting his average physical condition plus loss of sleep or dissipation." — C. K. Drinker.

## HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

The Ruling of June 28, 1920 for the Protection of Workers in Compressed Air. *Leymann.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 30–35. — An explanation of caisson disease and of the extent of work done under increased air pressure is followed by an abstract of the ruling. Besides technical details of construction which are prescribed for safety, the rates of compression and decompression are fixed and the maximum hours of work per day for the different pressures are stated. Medical examination of workers and supervision of the whole undertaking are required. First-aid information for the employees must be provided. For all work done at or over 2 kilograms per square centimeter, there must be a chamber in which persons suffering from caisson disease may be subjected to the same high pressure and then to gradually lowered pressures. — E. L. Sevringhaus.

## WOMEN AND CHILDREN IN INDUSTRY

A Physiological Basis for the Shorter Working Day for Women. *George W. Webster.* U. S. Dept. Labor, Women's Bureau, Bull. No. 14, Feb., 1921, pp. 20. — Dr. Webster points out the wastefulness of the "trial and error" method in discovering "the minimum number of hours in which the laborer may produce the maximum output, day after day, week after week, year after year, and remain well, at least as far as injury from overwork is concerned." Scientific methods of determining the right number of working hours in each industry are urged. Fatigue is discussed as the one element in the living machine different from the non-living machine.

Fatigue is a protective device, and neglect of it may lead to physiological bankruptcy. This means economic waste and a waste of life as well. Fatigue is produced by labor, speed, monotony, noise, machine rhythm, and shop conditions of ventilation, temperature, humidity, etc. The psychological causes of fatigue are found in the "balking" of some of the fundamental instincts. In the development of manhood some expression for such instincts as self-preservation, self-expression, workmanship, self-sacrifice, home making, loyalty, and worship must be found. It is the development of manhood to which an industrial and social system must be directed. We must not foster the "balked" disposition.

The measure of industrial fatigue is to be found in output and spoiled work, in accidents, and in illness and occupational disease. The general consequence of fatigue is physical debility which brings about lax moral fibre, which in turn leads to intemperance and inefficiency.

The legality of the limitation of working hours of adult women has been tested and reported upon favorably as a protective health measure for the well-being of the prospective mothers of the future race. The agreement of many leaders of opinion is for the eight-hour day for women. — Elinor D. Gregg.

Physical Standards for Working Children, a Preliminary Report of the Committee Appointed by the Children's Bureau to Formulate Standards of Normal Development and Sound Health for the Use of Physicians in Examining Children Entering Employment and Children at Work. Children's Bureau Publication No. 79, 1921. — The child who goes to work between 14 and 18 years of age is in need of special protection if he is to arrive at maturity with good health and a vigorous and well-developed body. During these years he is passing through the most critical period of his physical development, when his body must meet the unusual demands of rapid growth and physiological readjustment. If at the same time he is subjected to the mental and physical strain of gainful employment, the burden upon his immature physique is a double one, and special precautions are necessary if normal growth and development are not to be endangered.

The mandatory requirement of a physical examination for every child securing an employment certificate is now found in the laws of eighteen states, but adequate enforcement of this provision of the child labor laws depends upon definite standards of physical fitness and upon thoroughness and uniformity in making examinations. As the result of a resolution passed at the Children's Bureau Conferences on Standards of Child Welfare in 1919, a committee of physicians was appointed by the Children's Bureau to formulate definite standards of normal development and physical fitness for the use of physicians in examining children applying for employment certificates. The membership of the committee is as follows: Dr. George P. Barth, Director of Hygiene, City Health Department, Milwaukee, Wisconsin, Chairman; Dr. Emma M. Appel, Employment Certificate Department, Chicago Board of Education; Dr. S. Josephine Baker, Chief, Bureau of Child Hygiene, Department of Health, New York City; Dr. Taliaferro Clark, representing the U. S. Public Health Service; Dr. C. Ward Crampton, Dean, Normal School of Physical Education, Battle Creek, Michigan; Dr. D. L. Edsall, Dean, Harvard Medical School, Boston; Dr. George W. Goler, Health Officer, Rochester, New York; Dr. Harry Linenthal, Industrial Clinic, Massachusetts General Hospital; Dr. H. H. Mitchell, representing the National Child Labor Committee; Dr. Anna E. Rude, Director, Hygiene Division, U. S. Children's Bureau; Dr. Thomas D. Wood, Chairman on Health Problems and Education, Columbia University; Miss E. N. Matthews, Director, Industrial Division, U. S. Children's Bureau, Secretary.

The preliminary report of this committee

contains certain minimum standards of physical fitness for children entering and working in industry, which include standards of normal development and standards of sound health and physical fitness for employment. Under the latter the following defects for which children should be refused certificates are named: (1) cardiac disease, with broken compensation; (2) pulmonary tuberculosis or other evidence of serious pulmonary disease; (3) active glandular tuberculosis; (4) active tuberculous or syphilitic disease of joints or bones; (5) total blindness (unless no further educational facilities can be provided for such children); (6) total deafness (unless no further educational facilities can be provided for such children); (7) trachoma; (8) chorea; (9) syphilides; (10) hyperthyroidism; (11) acute or subacute nephritis; and (12) hookworm.

A list of remediable defects for which children should be refused certificates pending correction is given as follows: (1) defective vision subject to correction by glasses; (2) contagious eye and skin disease; (3) defective teeth — extraction or prophylactic care needed; (4) malnutrition requiring supervision or medical attention and not under treatment; (5) untreated inguinal or femoral hernia; (6) diseased tonsils; (7) defective nasal breathing requiring correction and not under treatment; (8) discharging ears not under treatment; (9) orthopedic defects not under treatment; (10) intestinal parasites (other than hookworm) not under treatment.

Provisional certificates for a period of not more than three months may be issued, according to the report, on recommendation of the medical examiner under the following conditions: (1) where treatment has been started but not completed in such cases as (a) defective teeth, (b) malnutrition, (c) orthopedic defects, (d) defective nasal breathing, (e) discharging ears, (f) intestinal parasites (other than hookworm); (2) partial blindness; (3) partial deafness; (4) other defects (not specified above) which in the opinion of the medical examiner require supervision.

In addition to specific minimum standards for entrance into industry, the report makes a number of general recommendations. Among the most significant of these are the following: The minimum age for entrance into industry should be set at 16 years, since pubescence is a time of special strain for the child; no child between 16 and 18 years of age should be permitted to go to work until he has had a complete physical examination and has been declared to be of normal development, in sound health and physically fit for the work at which he is to be employed; children at work should be re-examined when changing occupations and should have at least one yearly physical examination up to the age of 18; methods of examination should be uniform and centralized under state control; physical examinations of schoolchildren should be made for the purpose of discovering and correcting physical defects before the child reaches working age; special study should be made by local administrative and medical officers of occupations in which children are employed and their effect upon health. The need of authoritative scientific investigation of the effect of different kinds of work upon the health and physique of the adolescent child is emphasized, and a suggestive list is given of subjects with reference to which special research is needed.

A record form for the use of physicians in examining children and instructions for filling in the form are included. An appendix gives the laws relating to physical requirements for employment, in effect on January 1, 1921.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

SANITATION. *C. F. Wright* and *Miss Slocock*. Ann. Rep. Chief Inspect. Factories and Workshops for the Year 1919. London, 1920, pp. 47–57. — This report on sanitation includes items in respect to cleanliness and hygienic conditions, washing conveniences, sanitary conveniences, temperature, flueless gas stoves, lighting, and dust removal.

There is a general improvement in cleanliness and hygienic conditions, partly due to getting back to pre-war conditions, and partly to the continuation of experiments and improvements begun during the war. The introduction of vacuum cleaners in some places is observed, and improvement in whitewashing and cleaning; and attention to cleanliness on the part of the workmen is noticeable. Tenement factories, particularly those let out in

small single rooms as in the Sheffield cutlery trade, are generally found to be in poor condition as regards sanitation. The reports from nearly all divisions have some reference to floors, and show that even where walls and ceilings of workplaces are clean, the floors frequently receive inadequate attention. It is recommended that more consideration be given to the effects of brighter decoration in factories.

Progress in providing washing conveniences is slow. Some employers complain that these conveniences are seldom used, but in such cases inquiry usually shows that hot water, soap and towels have not been provided, and that there is a lack of supervision, the importance of which needs to be emphasized.

In the matter of sanitary conveniences, reports show very great variation of standard throughout the country; in some factories there are modern conveniences equal to those provided in first-class buildings, while in others the most primitive and insanitary arrangements are still found. The conditions are found at their worst in some of the cotton towns and also in tenement cutlery factories.

The question of heating, especially in large factories such as engineering shops, is receiving much attention, and considerable advancement is being made in the installation of the "unit system." In this system, the unit consists of a fan which forces the air under pressure downwards over steam-heated pipes and so distributes the heated air at floor level, where the effect is most felt by the workers. Textile factories have special problems; wool sorting shops are apt to be too cold, while in wool combing and carbonizing works high temperatures are likely to be found. The conditions in wool combing have been changed by improved ventilation, as have also the conditions in carbonizing shops. High temperatures have also been reduced by the use of electric light instead of gas, by increasing the air inlets, and by the extraction of hot air near the point of origin. The douche system of air cooling, by which cold air is blown by fans into the space where the men are at work, is another development. This has been adopted in many glass works, in the tinplate works and elsewhere.

The flueless gas stove came into more frequent use in England during the war, although there is much to be said against it. As a substitute, a new electric steam radiator is mentioned, in which water is vaporized by electric current. For lighting, diffused ceiling lighting is coming more and more into vogue, the arc lamp is disappearing, and the "half-watt" lamp is taking its place. "This lamp is described as the last word in efficiency, as it gives a brilliant light for small energy consumption." Objectionable glare can be overcome by proper shading.

"Very satisfactory reports have been received as to the solution of the problem of dust removal in the preparing departments of hemp, jute, and flax mills." In the future, the machine makers can adapt their machines and arrange them in the mills to co-operate with the ventilating plant. An improved system of "stack mixing" is mentioned (page 55). The dust conditions in the cotton card rooms are discussed at some length. In the potteries the conditions are not entirely satisfactory, and some of the attempted solutions have not been at all successful. Recommendations are made in regard to the dust problem in dolomite grinding.

The report closes with some evidence of the failure of the regulations to record humidity in cotton cloth works. The workers still refuse to make joint readings of hygrometers with the employer's representative. The need of a self-registering hygrometer is emphasized. — G. E. Partridge.

Sanitation in Bakeries. *H. E. Barnard.* Am. Jour. Pub. Health, May, 1921, 11, No. 5, 439–451. — This is a brief review of the salient points in modern state laws regulating the bread baking industry, and lays particular stress on requirements for physical examinations before employment, on general sanitary regulations of bakeries, and on the prohibition of the resale of stale loaves. The use of the bread box outside of retail stores is condemned in spite of regulatory restrictions.

The modern bakery has deserted the cellar and back street and does its work in modern buildings, even in the broad light with the consumer for a spectator. Industry is frequently in opposition to legislation, but here the bakers have demanded laws for bettered conditions of construction, maintenance and health for employees. — H. F. Smyth.

Industrial Painting. Safety Engin., Feb., 1921, 41, No. 2, 65–66. — According to the Electrical Testing Laboratories of New York a surface of pure white glossy paint increases lighting 19 to 36 per cent. It is, therefore, an

industrial economy to have factory workrooms and machinery painted in light colors, both from the standpoint of the amount of illumination required and the physical strain put upon the workmen producing in ill-lighted rooms. — M. Dent.

Where Light is Wasted. Factory, Dec. 1, 1920, 25, No. 11, 1808. — A company that manufactures paint has recently made a series of tests to discover which colors are the best reflecting mediums. Where indirect lighting is used, a well-painted white ceiling will give 20 or 30 per cent. more illumination intensity than an ordinary white, buff, or similar colored ceiling. The table below gives the percentage of the incident illumination that is reflected by walls of different colors:

| | Per Cent. |
|---|---|
| White enamel | 80 |
| White | 79 |
| Cream, flat tone | 71 |
| Pearl gray | 63 |
| Buff, flat tone | 59 |
| Pink, enamel | 57 |
| Satin, green | 56 |
| French, gray, enamel | 39 |
| Pale azure, flat tone | 36 |
| Blue, enamel | 31 |
| Green, enamel | 29 |
| Red, enamel | 27 |
| Brown, flat tone | 22 |
| Forest green, flat tone | 21 |
| Wine, enamel | 12 |
| Gas green, enamel | 10 |

— M. C. Shorley.

How 17 Everyday Lighting Problems Have Been Solved. *S. G. Hibben.* Factory, Dec. 1, 1920, 25, No. 11, 1737–1740. — "No lighting engineer can foresee all the peculiar lighting requirements of any industrial plant." Perhaps the industrial manager will find among the examples mentioned in this paper an application which will fit his conditions, or will be able to profit from a survey of what others have done under similar circumstances. — M. Dent.

Recent Advances in Mine Illumination. *Heinrich Müller.* Zentralbl. f. Gewerbehyg., Jan., 1921, 9, No. 1, 11–15. — This is a survey of the types of miners' lamps. Stationary electric installations are also described, and considerable attention is paid to the mechanical devices by which explosions of mine gas are prevented in case the glass globe is broken or opened while the lamp is lighted. Neon-filled bulbs are briefly commented on. — E. L. Sevringhaus.

Making the Factory a Better Place to Work. Factory, Jan. 1, 1921, 26, No. 1, 29. — The Faulkner and Colony Manufacturing Company has solved the problem of excessive humidity in the ventilation of dye houses and bleacheries by placing pipes to carry warm air directly over the tubes and machines from which steam and vapor are originating, and to form the moving film of warm air along surfaces where condensation is likely to occur and cause disagreeable dripping. — M. Dent.

Ventilation in Metal Mines. *Daniel Harrington.* U. S. Bur. Mines, Tech. Paper 251, 1921, pp. 44. — This bulletin deals primarily with the atmosphere in which miners work in metal mines, its contamination from various sources, the effect of different contaminations, the methods of ventilation used and the need of improved ventilation, and recommendations for improvement, but it also touches upon the three other subjects which the Bureau of Mines is investigating, namely,

"1. The effect of various kinds of mine dust in relation to miners' pulmonary diseases and the preventive measures suggested.

"2. Humidity of the atmosphere in metal mines, the effect of high humidity on the health and the working efficiency of miners, and how conditions can be improved.

"3. The high temperature found in deep mines and in some comparatively shallow mines, its effect on the health and morale of workers, and how the temperature may be lowered to proper limits or its ill effects overcome." — M. Dent.

Industrial Wastes in Relation to Water Supplies. *W. Donaldson.* Am. Jour. Pub. Health, March, 1921, 11, No. 3, 193–198. — The effect of industrial waste on public water supplies is generally manifested either as disagreeable odors and tastes, foreign substances making the water unsightly and unsuitable for use or else interfering with proper functioning of purification works, or as chemical substances in solution causing damage to water works structures or rendering water less fit for domestic or industrial use, whether or not detrimental to health.

On account of the multitude of waste substances derived from industry, the variety of

effects on water supplies are numerous. This article considers in some detail the effects of coal mine wastes containing acids in solution or coal dust in suspension; aromatic coal distillation wastes from gas houses, containing phenols, cresols, etc., the odors and tastes from which are accentuated by chlorination; wood distillation wastes; oily and salt wastes from oil well operations; and wastes from oil refineries, tanneries, paper mills and other industries.

The principal responsibility for preventing stream pollution by industrial wastes should be placed on the plants themselves. But municipalities should not depend upon out-of-date purification plants stereotyped in design and planned primarily for removing sewage effects, turbidity, and color. State health officers should have regulating powers under standardized laws conforming to federal practices. — H. F. Smyth.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

MEDICAL WELFARE WORK IN SMALL FACTORIES. *A. C. Burnham.* Mod. Med., Feb., 1921, 3, No. 2, 90–92. — Dr. Burnham combines several studies to show that the industrial plants employing less than 500 workers give very little medical or surgical care beyond that required by the prevailing compensation laws. Among employers of small forces of labor the consensus of opinion is that welfare work has no effect on labor turnover or production. Among the large concerns the opposite opinion is held. The prevailing equipment among the small factories is not generally adequate, while that in most large concerns offers every facility to the hospital personnel. In the large establishments the number of workers to each unit of the medical personnel varies between 700 to 1,000.

A co-operative scheme would be the best way to secure for the smaller concerns the results which are being obtained by the large plants. Several different plans have been tried, some of which, with further development, would be adequate. In some cities the employers are organized to furnish information in regard to such matters as traffic, casualty insurance and employment; this might be extended to medical care. The plan of a number of doctors combining in a commercial way to establish a dressing station in the vicinity of a group of factories has proved more or less satisfactory according to the character of the doctors, but the commercial element is apt to defeat its own purpose. The health stations that have been started by the State Boards of Health might readily be extended to cover accidents and general medical care though at present they are confined largely to the study of industrial disease and industrial hygiene. Perhaps the most sure of success is a co-operative service in charge of a voluntary organization, such as the Red Cross. This is more apt to command the loyalty of the people and administrative changes are more easily made. There is, however, need of more accurate information as to the expense of such ventures. Certainly a co-operative dispensary where there were no hospital facilities would prove of great value to the industries and to the whole community. — Elinor D. Gregg.

BUDA CO. MEDICAL SERVICE. *H. M. Tupper.* Hosp. Management, Dec., 1920, 10, No. 6, 62. — This is chiefly an account of the physical examinations given by the Buda Company medical department and of the various causes for rejection of applications. — M. Dent.

FACTORY EYE ROOM SAVES WORKERS' SIGHT AND INCREASES OUTPUT. *Sanford DeHart.* Indust. Management, Jan. 1, 1921, 61, No. 1, 23–24. — It is estimated that there are 15,000 persons in the United States at the present time who are blind as a result of industrial accidents. Statistics show that 200,000 accidents to eyes occur every year, or about 8.3 per cent. of the total number of industrial accidents. Since it has been shown that it is practically impossible to eliminate entirely the eye hazard in industry, it is necessary to learn how to attend efficiently to accident cases. As an illustration of what is needed, the writer describes the eye room and the service rendered in the plant of the R. K. Le Blond Machine Tool Company. This eye room is a room 4 feet square, painted black inside. It contains a glass shelf with the various eye solutions needed and an adjustable chair, and has overhead

illumination. The room is used primarily for the removal of foreign bodies from the eye and for subsequent treatment.

The result of the special attention given to eye cases in the plant has been, first, a great reduction in the number of eye cases and in lost time resulting from them; and secondly, the severity of eye cases has been greatly reduced, largely on account of educational propaganda dispensed in the eye room. The men are taught to appreciate the value of goggles, various types of which are supplied by the hospital, the most popular type proving to be one having a very light construction with leather nose-piece and side-pieces. The results accomplished are in every way satisfactory and encouraging, and the writer thinks that the method used by this company is well worth adopting elsewhere. There is no reason, he thinks, why the industrial physician cannot attend to the removal of foreign substances from the eye in ordinary cases and administer the necessary subsequent treatment as well as the specialist. The cost of installing the equipment is slight, not more than $300. At the present time there appear to be only three industrial plants in this country operating their own optical rooms in connection with their hospitals. — G. E. Partridge.

## INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

Some Practical Hospital Problems Encountered in an Industrial Community. *E. M. Stanton.* Boston Med. and Surg. Jour., Nov. 25, 1920, 183, No. 22, 623–628. — The problem of furnishing adequate medical, surgical and hospital facilities to the middle class — 90 or 95 per cent. of the population — of Schenectady, N. Y., is described and the solution is given. Charity patients have been made municipal charges and supported by the city. Industrial plants are not asked for endowments but are required to pay for whatever service is rendered. By these and other means the hospital has been made self-supporting. — Barnett Cohen.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

Tuberculosis Survey of a Silk Mill Village. *L. B. McBrayer.* Am. Rev. Tuberculosis, Feb., 1921, 4, No. 12, 920–925. — The conclusions reached by the author are: "It was our opinion, from these studies, that the silk mill *per se* was not responsible for the tuberculosis, but that it was a matter largely if not wholly of contact infection, and that all the original cases developed at some other place and moved into the silk mill village and of course continued to communicate the disease to those with whom they associated most closely, who in most instances were the members of their own family." — M. C. Shorley.

## INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

New York State Industrial Code. N. Y. Bur. Statis. and Information, 1920, pp. 248. — A compilation of rules and regulations supplementary to the labor laws, which have the effect and force of law, for the sanitation, lighting and safeguarding of all factories, foundries, building trades, etc., in the state of New York. — M. Dent.

Austrian Legislation for Protection of Workers from 1913 to 1920. *Jenny Adler-Herzmark.* Zentralbl. f. Gewerbehyg., Jan., 1921, 9, No. 1, 19–24. — A résumé is given of the emergency legislation of the war period which removed some restrictions for the sake of production.

After the new government came into power in November, 1918, machinery was set in motion for the re-employment of soldiers as soon as they were demobilized. Unemployment insurance was provided up to April, 1920, for all those who had been under sickness insurance laws before the war, and the former rules on Sunday and holiday work were restored. The

years 1918 and 1919 saw wide extensions of the eight-hour day laws; regulation of industry in the home was established, with local committees; child labor was further regulated as to hours and conditions of non-interference with health and school. In February, 1919, consolidation of sick benefit organizations was authorized. (*To be concluded.*) — E. L. Sevringhaus.

Austrian Legislation for Protection of Workers. *Jenny Alder-Herzmark.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 25-27. (*Conclusion.*) — The legislation for 1919-1920, which is reported in this article, includes laws (*a*) forbidding night work for butchers; (*b*) requiring an eight-hour day, no night work, time and one-half for overtime in bakeries, and medical certificates for apprentices; (*c*) requiring that all employees under 17 years be given an uninterrupted vacation of four weeks with certain payments in case of illness; (*d*) forbidding night work for women and all persons under 19 years; (*e*) granting vacations with pay to all employees — one week for those who have served in the industry a year or more, two weeks for those who have worked five years; (*f*) permitting child labor in hotels and public houses with restrictions as to hours of sleep and daytime rest. — E. L. Sevringhaus.

The New Law for Protection of Workers in Holland. *H. J. Scholte.* Zentralbl. f. Gewerbehyg., Feb., 1921, 9, No. 2, 27-30. — A tabular presentation, with some explanations of the new law, shows the detailed specification of the hours of work, Saturday half-holiday and Sunday holiday provisions, and their application to the men, women, or young workers. Domestic service, drugstores, and agriculture are excepted from the law. — E. L. Sevringhaus.

The Trend of Workmen's Compensation. *Will J. French.* U. S. Bur. Labor Statis., Month. Labor Rev., Nov., 1920, 11, No. 5, 875-883. — The most important recent development of workmen's compensation legislation is in extending benefits to include vocational re-education and rehabilitation. Federal aid is given to states that will participate in relieving crippled workmen. Another development is the extension of workmen's compensation acts to broader coverage of industries, that is, beyond the extra-hazardous and the hazardous occupations.

A uniform federal compensation act is needed for interstate railway employees and maritime workers. But this law would infringe in the one case upon states' rights, and in the other would conflict with admiralty laws and the laws of maritime states. A practical solution would be for Congress to enact a uniform federal measure with a provision that the different state compensation boards and commissions should have concurrent jurisdiction with the federal courts in determining suits arising under it. — Elizabeth C. Putnam.

Workmen's Compensation Legislation in Canada. Labour Gaz., Aug., 1920, 20, No. 8, 1012-1020. — A comparison is made of the somewhat widely variant provincial laws on the subject of workmen's compensation, in the interest of greater uniformity for the future. Compensation for industrial accidents has been provided for by law in all Canadian provinces with the exception of Prince Edward Island. The Canadian laws follow mainly the British Employers' Liability Act, which was passed in 1880 and which represents a change of view from the older idea in regard to the proper incidence of the risk in industrial work. The province of Quebec forms the single exception, since here the civil law is based on French law.

In the provinces of Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia and Ontario, the tendency has been along the line of the German system of workmen's compensation. The employers' liability acts have gradually been replaced in these provinces by a plan of collective liability and an exclusive state fund such as the one adopted in the state of Washington. Six provinces have exclusive state insurance; six provinces and the Yukon pay compensation to workmen without regard to the amount of their remuneration. In all the provinces and the Yukon, the burden of payment rests on the employer, but in some provinces the liability is borne collectively by groups of employers. Full medical and hospital aid is furnished in five provinces. Six provinces make injuries due to some industrial diseases compensatable. There is little uniformity in meeting the cost of administration. The scale of benefits shows more uniformity in the compensation allowed in cases of death than in that for disability. The survey as a whole shows that the majority of the Canadian provinces have gradually been adopting the principles which the commission, appointed in April, 1920,

recommended as standard provisions for uniform provincial laws on workmen's compensation. — G. E. Partridge.

Legislation Now Needed to Restore Compensation to Longshoremen. *Joseph P. Chamberlain.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 241–245. — "There are two classes of workmen in the service of ships: one class includes longshoremen — men employed in loading and unloading the ship while it is in port, and carpenters, machinists, painters and repairmen who refit it for the next voyage; the other includes the men of the sea — the master and the crew." The "men of the sea" are a class apart: they are migratory, touching in many lands under many laws; for them, uniformity in law is possible only under an act of Congress administered through federal courts or commissions. Longshoremen and repairmen are in a wholly different situation. They are attached to one locality; they may be employed on the docks on strictly land jobs; they may be, for instance, builders' men sent down for half a day to unload a cargo of bricks. It is hard to see why they should not be treated on the same basis as other local workmen; but because of arbitrary rules of law their position is anomalous. If injury to such a man occurs on a ship, the question of damages is decided on the basis of admiralty law; if it occurs on shore or even on the wharf, but not in direct relation to the ship, the case comes under the state compensation act; if the man is injured while on his way to the ship, he may neither sue in admiralty, since the accident occurred on shore, nor be compensated under state laws, since he is a "maritime worker." His only redress, then, is to sue for damages for tort under the common law. Moreover, if the accident happens on the gang plank, it is doubtful whether he can be compensated in any way. The wise solution is for Congress to enact promptly "a law restoring the protection of state workmen's compensation laws to these essential workers who are engaged in especially hazardous occupations along every waterfront of the country." — Elizabeth C. Putnam.

Workmen's Compensation Legislation of the United States and Canada. *Lindley D. Clark* and *Martin C. Frincke, Jr.* U. S. Bur. Labor Statis., Bull. 272, Jan., 1921, pp. 1211. — This bulletin takes up the progress of compensation legislation, together with an analysis of the principal features of the laws and their texts in the various states of the Union and the provinces of Canada. — M. C. Shorley.

Cost of Occupational Diseases under Workmen's Compensation Acts in the United States. *Carl Hookstadt.* Month. Labor Rev., Feb., 1921, 12, No. 2, 154–159. — This interesting article includes six tables illustrating federal and state experience with occupational diseases. — R. B. Crain.

Workmen's Compensation and Social Insurance, Comparison of Compensation Insurance Systems as to Cost, Service, and Security. *C. Hookstadt.* U. S. Bur. Labor Statis., Month. Labor Rev., Dec., 1920, 11, No. 6, 135–156. — The writer has made a detailed study of compensation insurance systems in twenty-one states and two Canadian provinces, during which he visited the industrial commission of each of these states and provinces. A comparative account is given of: the funds; the cost; the service in regard to promptness, adequacy or liberality of payment; accident prevention; and the security offered to employer and employee.

Three main types of states with respect to compensation insurance are described: states having exclusive state funds; states having competitive state funds; and states in which there is private insurance. Under an exclusive state fund the cost to employers would be 30 per cent. less than under stock insurance and $12\frac{1}{2}$ per cent. less than under mutual insurance. The total saving to insured employers of the United States, if all were insured in exclusive state funds, would be more than \$30,000,000 annually.

In promptness of payment there is little difference between the different types of insurance carriers. Some of the state funds have the best records, while others are among the poorest; this is true also of stock companies and mutual companies. The best managed state fund, however, is more prompt in its payments than the best private company. As regards liberality of payment, most of the state funds are more liberal than either stock or mutual companies. In accident prevention some of the private companies are doing excellent safety work, whereas few of the state funds have done any effective safety work.

Thus far no injured workman has lost any compensation due because of the insolvency of state insurance funds, and no large mutual in-

surance company has become insolvent. There have been, however, several bad failures of private stock companies during the past three or four years. The experience of twenty-one states in respect to self-insurance has been reported. In fifteen of these states no self-insured employer has failed or gone into the hands of a receiver. Only two of the remaining six states reported failure on the self-insurance plan resulting in claims being unpaid, and these involved only one small company in each of the states. — G. E. Partridge.

PREVENTABLE LOSSES IN CASUALTY INSURANCE. *John C. A. Gerster.* Mod. Med., Nov., 1920, 2, No. 11, 728–730. — This article contrasts the common negligence of casualty insurance companies regarding basic surgical principles with the policy of life insurance companies in keeping abreast with medical and surgical progress affecting their interests. The failure to appoint "expert buyers of the commodity, surgical treatment," is indicated as the fundamental error. In the writer's opinion, no claim agent, however capable, can judge the best surgical service. He believes that until casualty insurance companies avail themselves of up-to-date surgical service, as tried and proved by war experience, such companies will continue to pay about twice as much as they should for disability following injury.

A few self-evident surgical principles upon which claim departments should base their systems of administration are enumerated. Among these are the provision of expert surgical consultants; the provision of hospital facilities of the highest standards; and the provision of a medical intelligence department to keep track of the man from the time he is hurt until he is well.

The writer believes that the evils of the present system can be promptly and economically eliminated by the creation of a surgical department working in "close co-operation with the claims department." The functions of such a surgical department would include, besides the immediate technical functions, the following: (1) insistence upon immediate report of accidents by telephone; (2) maintaining a daily follow-up system; (3) supervising of medical bills from outlying districts; (4) analysis of results.

Educational measures are advised for instructing claim-agents, employees and employers in practical surgical principles with the purpose of securing immediate and adequate surgical care in all emergencies. — H. W. Stevens.

A STATISTICAL REVIEW OF DISABILITY IN THE WORKMEN'S CIRCLE. *George Rubin* and *Joseph Baskin.* Mod. Med., Nov., 1920, 2, No. 11, 730–733. — A study based upon the experience of this organization in sick benefits paid to its disabled members.

For the purpose of comparison all occupations are grouped into twenty-one classes, including housewives and a miscellaneous group termed "other occupations." The results of the study are presented in several tables.

Tables I, II, and III deal with the relation between age and disability. Table I, covering a period of four years, gives the annual average number of disability-days per member and per disabled member of each classified five-year age group. Table II shows the deviation from the average for each age group, the 0 deviation falling between the groups thirty to thirty-four and thirty-five to thirty-nine. Table III shows the relative responsibility of each age group for disability. This is the highest in the thirty to thirty-four group.

Tables IV, V, and VI deal with the relation of occupation to disability. Twenty-one occupation groups are distinguished. The occupation of housewife shows the highest apparent responsibility, followed in order by that of laborer, baker, painter, and machinist.

Tables VII and VIII present the relations of various diseases to disability. Influenza, injury, infection (surgical) and digestive disturbances, in order, are the leading causes, considering the numbers of disabled members; while injury, tuberculosis, influenza and digestive disorders are the chief causes of disability measured in days.

Several charts illustrate graphically the facts of the tables. — H. W. Stevens.

THE SOCIAL HYGIENIC RESULTS OF THE GERMAN WORKMEN'S AND EMPLOYEES' INSURANCE IN THE WAR AND ITS PROBLEMS IN THE FUTURE. *W. Hanauer.* Abstracted as follows from Veröff. a. d. Geb. d. Med.-Verw., Vol. 10, pp. 483–573, by Holtzmann in Hyg. Rundschau, Sept. 1, 1920, 30, No. 17, 536–537. — "During the war workingmen's sick funds, labor unions and, above all, state insurance organizations made their resources and ability available for public health ends, for the provision of hos-

pitals and comforts for the soldiers in the field. The author describes only those branches of social hygienic care in which the organs of the R. V. O. are concerned.

"To fight tuberculosis advance stations were erected for the sifting of material to be sent to the hospitals for lung cases. Active co-operation with the charitable organizations is to be desired to assure the carrying out of the treatment. The beginning of the tuberculosis campaign among children by the insurance organizations is welcome. The battle against venereal diseases received a great impulse during the war. Consultation offices of different types were erected by the state insurance organizations, the attendance at which, however, leaves more to be desired.

"In industrial hygiene it was discovered that wartime substitutes for oils increased skin diseases. The widespread use of explosives gave occasion, according to Section 547 of the R. V. O., to a comparison of sickness due to these substances with injuries following accidents. In maternity cases the ruling of Sept. 11, 1914 on aid during confinement in war time gave the workmen's sick funds occasion for energetic helpfulness. Experience gained in this way was crystallized in the imperial law for maternity aid which affords to all people of small means the benefit of care during pregnancy and confinement. In the matter of housing, the local workmen's sick fund at Pforzheim was a pioneer in propaganda and raising funds for the building of small dwellings. Social insurance and care of war casualties are in close relation; representatives of workmen's sick funds, labor unions, and insurance commissions make up the committees on the care of war casualties. Industrial therapy for the most complete possible rehabilitation of war cripples to a self-supporting state was improved by the unions in line with the favorable experience after the war.

"In conclusion the author suggests expansion and changes in social insurance. He desires officially appointed physicians with a social hygienic training for the workmen's sick funds, as subordinate to whom the 'controllers of the sick' might serve. The hypothesis upon which all this is based is that the German people will be able to work their way up out of their impoverishment." — E. L. Sevringhaus.

Old Age Insurance Legislation Now up to the States. *Frederick MacKenzie.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 254–255. — The United States is alone among the great civilized nations in not having attempted a permanent solution of the problem of old age and dependency. A beginning has been made in several states, notably New York, where a law provides old age retirement and disability insurance for its public employees; and in 1920, after years of agitation, compulsory, contributory old age insurance has been established for federal employees in the classified civil service. Social responsibility for protecting old age against pauperism is recognized on the program of the April, 1921 meeting of the International Labor Conference of the League of Nations. "With legislative sessions during 1921 in nearly all states, the opportunity is at hand to bring America immediately abreast of the enlightened standards and experience of other great industrial nations. Bills must be passed in all the states before the United States can be said to have met its duty to those who have grown gray in the service of the public and of industry." — Elizabeth C. Putnam.

State Industrial Accident Insurance Officially Acclaimed. *Irene S. Chubb.* Am. Labor Legis. Rev., Dec., 1920, 10, No. 4, 258–260. — The outcome of a discussion at the recent convention of the International Association of Industrial Accident Boards and Commissions concerning the relative service, security and cost under commercial, mutual and state fund insurance, was strongly in favor of state funds. The benefits were found to be:

1. There is security to the workman.
2. There is security to the employer when he has paid his assessments to the state fund.
3. There is better feeling between employer and workman, because the state fund assumes the payment of compensation.
4. The industries of the state benefit by only paying a maximum of about eight cents to get one dollar to the workman, against sixty-six and two-thirds cents by stock companies.
5. The state benefits, because it will never be called upon to make good payments which should have been made by stock companies.
6. The employer is better satisfied, because he knows that every dollar which he pays in assessment is to be used to pay claims and legitimate expenses, which will not likely exceed 7½ per cent.
7. The employee is better satisfied, because he feels that his payments are in the hands of a board who have every reason to deal fairly with him.

"Taking everything into consideration, can we come to any other conclusion but that the exclusive state fund must be the permanent system?" — Elizabeth C. Putnam.

## REHABILITATION OF DISABLED EMPLOYEES

Training at Iowa State College. Voc. Summary, Nov., 1920, 3, No. 7, 99–101. — From district No. 9 a report is submitted regarding the work being done and the progress made by some Federal Board men enrolled in Iowa State College. Cases are mentioned to demonstrate the possibility of men suffering from physical disabilities and lack of education making good in a new vocation. — L. A. Shaw.

Industrial Rehabilitation in Oregon. *W. T. Kirk.* Month. Labor Rev., Oct., 1920, 11, No. 4, 1–8. — This interesting investigation of the work of the Industrial Accident Commission in Oregon was carried on with apparently an unusual degree of freedom. The work is divided into three departments. One department is devoted to auditing, bookkeeping, etc.; another takes care of the claims; and the third handles the statistical work. The work of vocational rehabilitation falls to the claims department. An effort has been made to simplify all the preliminary routine in accepting candidates for rehabilitation training and aid, and to treat all cases with reference to the especial needs and conditions of the case. Existing educational facilities are used, the co-operation of an expert in industrial education has been obtained, and each case is carefully studied. Liberal interpretation of eligibility to rehabilitation aid has been made (the rule is laid down that all should be eligible who have lost 50 per cent. or more of the use of an arm, hand, foot, or leg, or sustained other permanent disability of equal severity); and an attempt is made to provide adequate support for the man while he is undergoing training. The work is too new, the writer concludes, to allow definite statements of results, but several cases are presented as illustrations of the method of work of the commission. — G. E. Partridge.

Oregon System of Medical Service. *F. H. Thompson.* Mod. Med., Jan., 1921, 3, No. 1, 26–27. — Aside from administering a compensation fund the Oregon law for the compensation of industrial accidents makes provision for the prevention of accidents as well as for the best possible care of the disabled. To this end there has been established a department of physiotherapy similar to that in the work of army reconstruction. The medical department of the commission has the final decision as to the treatment of all cases. Thus, though the patient may originally choose his own physician or be treated by the company contract doctor, ultimately his condition is passed upon by the state authorities and almost invariably comes to the state institution for physiotherapy, there being very few such facilities in private practice as yet. The law provides for an expenditure of $250 for transportation, hospital and surgical care, and nursing. Any further expenditure must be advised by the commission. This enables the commission to proceed with reconstruction surgery and physiotherapy if it is needed.

No permanent, partial, or complete disability awards are made until all possible restoration of function is accomplished. For this purpose there are two fully equipped physiotherapy departments with trained army aids to carry on work. Physicians at first resented this as criticism of their work but this objection was overcome by sending to each physician a carbon copy of the order stating the reason for calling in the patient, and paying him in full for his care of the patient.

In cases of amputation, temporary total disability is continued until the artificial limb (paid for by the state) is secured. Vocational retraining for major permanent disability cases is strongly advised. Especially successful work has been done with ankylosed joints by physiotherapy, and much prevention of such conditions is being made possible by careful early supervision of all cases. This law aims to be most helpful to the injured, most economic to society and most satisfactory to the employer. — Elinor D. Gregg.

9,500 Partially Disabled Employees Working in Ford Motor Plant. Nat. Safety News, Jan. 17, 1921, 3, No. 3, 5. — The Ford Motor Company has admitted to its plant at Detroit about 9,500 crippled or diseased men. Among these men there are 123 at work who have suffered amputation of arms, forearms or hands, or who are hopelessly crippled in one of these members. One man has lost both hands; 4 are totally blind; 207 are blind in one eye; 253 have light-perception only in one eye; 37 are deaf and dumb; 60 are suffering from epilepsy; 234 have had amputation of one foot or leg, or are hopelessly crip-

pled; four have lost both legs or feet; 1,560 are suffering from hernia; and 900 are tuberculous men. — G. E. Partridge.

The Industrial Question: A Proposal and Announcement. *Frederic J. Cotton.* Boston Med. and Surg. Jour., Feb. 10, 1921, 184, No. 6, 135–137. — Industrial accident cases are similar in many ways to wound cases in the army, and the successful methods of treatment and rehabilitation evolved for the war-wounded should be applied to the maimed and wounded in industry. Faulty methods of treatment have, in the past, resulted in a great amount of economic and human waste. Large general hospitals have been too busy to handle such cases properly. Smaller community hospitals have done better, but few of them are fully qualified for this work in equipment and personnel. Private physicians have done surprisingly well, perhaps because of greater interest in their cases. Plant hospitals affiliated with good local hospitals are especially equipped for the work and promise good results.

To improve the chances of the injured employee of a small concern, two things are advocated: (1) a systematic review of all cases on compensation over a few weeks to see what should be done and whether it is being done; and (2) an arrangement by which serious cases needing expert treatment can easily secure it, whether they are under the care of their own doctor, of the company doctor, or of the insurance company. — Barnett Cohen.

## INDUSTRIAL MORTALITY AND MORBIDITY STATISTICS

Diseases Prevalent among Steel Workers in a Pennsylvania City. *D. K. Brundage.* U. S. Pub. Health Ser., Pub. Health Rep., Dec. 31, 1920, 35, No. 53, 3163. — In connection with the collection and study of industrial morbidity statistics, a report of a large employee's sick benefit association which has been furnished the Statistical Office of the U. S. Public Health Service has been selected as typical, and is presented here for the purpose of pointing out (1) what such a report *actually* shows and (2) what salient facts such reports *might* reveal concerning the occurrence of disease in the group of industrial workers under consideration. — L. A. Shaw.

Sickness Frequency among Industrial Employees. U. S. Pub. Health Ser., Pub. Health Rep., March 4, 1921, 36, No. 9, 429–434. — This is a statistical study of morbidity among a group of wage earners for the first nine months of 1920. Only cases lasting over one week are reported. The sickness frequency in February is the highest reported, being twice that of September, exclusive of influenza cases.

Apparently, the hot weather diseases do not last as long as one week. Diseases of the pharynx are of very high incidence during the first three months of the year. Rheumatism is high in the first half of the year. Occupational poisonings are becoming comparatively rare.

Tables are given to illustrate the data. Many of the interesting questions are still to be put and still to be answered. A more complete report will be given at the end of the year. — Elinor D. Gregg.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

VOLUME III SEPTEMBER, 1921 NUMBER 5


## CONTENTS



## GENERAL

INDUSTRIAL HYGIENE. *Sir Thomas Oliver.* Internat. Labour Rev., Feb., 1921, 1, No. 2, 153–158. — Among the international labor problems respecting the hygiene of labor, the smelting of lead ore and the manufacture and use of lead compounds should be considered. With the exception of lead ore in the form of cerussite or carbonate, lead mining has not been a cause of plumbism, although the miner has been liable to pneumoconiosis and pulmonary phthisis from the inhalation of hard metallic dust. Lead in the form of galena, or sulphide, is very insoluble, but the question has been raised recently whether, through the action of air and other as yet unknown agencies, a conversion of underlying veins of galena into soluble carbonate does not take place. This problem has been raised in regard to the Broken Hill mines of Australia, but it is of general interest.

Previous to the war, ankylostomiasis had been a cause of ill health and of death among the coal miners in Hungary and Westphalia, as well as of sickness among the tin miners of Cornwall and the agricultural laborers of the United States, the West Indies and other places. With our wider knowledge of the disease, ankylostomiasis should in the future claim fewer victims.

Occupation in mines and factories still results in too large a loss of life from accident. Many factors call for further consideration, such as faulty lighting, too long hours and fatigue, impaired eyesight, the defective factory plant, and the effects of alcohol. — G. E. Partridge.

HEALTH CONDITIONS AT BROKEN HILL MINES. *Melville Birks.* Jour. State Med., April, 1921, 29, No. 4, 121–125. — The Broken

Hill mines are situated in New South Wales and yield lead and zinc sulphides mainly. The workings are not over 1,500 feet deep and temperatures do not run very high. The atmosphere of the mines has a high dust content.

Lobar pneumonia is particularly fatal for the underground workers. The cause for this has not been determined, but by a process of exclusion the dust of the sulphide ore is suspected as being in some way the determining factor. Silicosis is only rarely produced by the dust of these mines, as over 100 postmortem examinations have shown. Some of the mines still produce some lead carbonate and in these a few cases of typical plumbism occur; but a great many men have symptoms resembling a chronic form of lead poisoning which is apparently caused by working with the sulphide ore. Nystagmus and hookworm disease are absent among the miners. — Barnett Cohen.

The Social-Hygienic Conditions of Hotel Personnel in Rome. Abstracted from Bollettino dell'Ufficio Municipale, 1919, in Il Lavoro, Jan. 31, 1921, 11, No. 9, 284. — It is difficult to ascertain the conditions of work for hotel employees on account of the reticence of hotel keepers as well as of employees. Conditions are good in hotels of the first order, good in 90 per cent. of those of the second order, and in 21 per cent. of those of the third order, but mediocre in 44 per cent., and bad in 35 per cent. of those of the third order. In general, sleeping quarters and food are good, but laundresses seem to be the exception to the rule. They work from eight to fifteen hours a day, with the Sunday rest not too well observed. — M. Dent.

Attendance of Workers in Moscow Factories. Internat. Labor Rev., Feb., 1921, 1, No. 2, 223-230. — The facts here given are taken from the report of the Moscow Section of Labour Statistics, which is part of the Commissariat of Labour. Tables showing the number of days worked in industries in Moscow and the causes of non-attendance are included, and figures in regard to absenteeism in Petrograd are offered for comparison.

In all industries, the average number of days worked in a month for the period from October, 1919 to June, 1920 was 17.0; in the textile industries, 13.9; and in the metal industries 17.1. The larger the factory, the smaller was the number of days of work. Non-attendance was due to various causes; in the textile industries, 5.1 days' loss was due to closing of the factory; in the metal industries only 0.2 days' loss was due to this cause. There was an average of 5.5 days of absence for all industries, due to various individual reasons, the metal industries showing 6.8 days — the highest rate of absence for these causes. Illness as a cause of absence is reported as amounting to 1.8 days. Holidays account for 6.1 days. The figures for Petrograd, given for a shorter period and with incomplete information as to how they were obtained, show a total absence in all industries of 12.4 days per month — 7.4 days due to sickness, and 5.0 days to voluntary absence. Among leather workers the sickness absence amounted to 13.2 days — the highest number reported; among needle workers, 11.3 days; among metal workers, 8.7 days; and among landworkers, 2.5 days — the lowest number reported. A table giving the figures for another period shows slightly different results, chemical workers and communal workers appearing above the metal workers in regard to days of absence due to sickness, and the leather workers and needle workers appearing in reversed order. — G. E. Partridge.

The Hours of Work in Relation to Quality of Output. *A. H. Ryan* and *P. S. Florence*. U. S. Pub. Health Ser., Pub. Health Rep., March 11, 1921, 36, No. 10, 517–519. — "Three jobs — stamping by means of a footpress, threading tube, and grinding — were carefully studied hour by hour throughout the day as regards the hourly output, the lost time, both voluntary and involuntary, and the number of errors or the number of pieces of spoiled or defective work. . . . The principle employed has been to analyze the job in terms of receptor stimulus and effector response. The footpress job, for example, involves, as regards spoiled work, only the visual receptor, whereas in the other two jobs both the visual and deep receptors are used."

"This analysis reveals that our three jobs are vastly different from the physiological standpoint. Where a single receptor is employed, with a relatively strong stimulus, as in the footpress job, the percentage of scrap is low and is practically uniform throughout the day. Where two receptors are employed, as in grinding springs and rolling thread, a rise in

the percentage of scrap occurs toward the end of the spell, the highest two-hour period being the last two hours of the day." — M. C. Shorley.

Practical Experience with the Work Week of Forty-Eight Hours or Less. Nat. Indust. Conference Board, Research Rep. No. 32, Dec., 1920, pp. 88. — This report "carries forward the Conference Board's earlier studies dealing with the hours-of-work problem." In previous reports which have been summarized in this Journal, the effects of reduction of hours upon output in the cotton, boot and shoe, woolen and other industries have been followed. In these reports there was also some effort to ascertain the effect of reduced hours upon the health of the workers but since the methods of investigation were largely those of the questionnaire and since there was little or no statistical knowledge as to health conditions prior to reduction of hours, the results were inadequate and disappointing.

In report 32 "only those establishments operating on a schedule of 48 hours or less were included. . . . Certain plants reporting a nominal schedule of 48 hours per week but having actual working hours regularly in excess of this time were necessarily excluded, because conclusions as to the effects of a reduction to a week of 48 hours or less could not properly be drawn from the experiences of such plants. Neither were those plants included in which manufacturing conditions had so radically changed as to invalidate a comparison of output in the periods before and after the change in hours."

The data presented were again attained by questionnaires, "checked by correspondence and by field work where necessary." No effort of consequence was made to determine effects of the forty-eight hour week upon health. A few comments upon this side of the question are included but are of little moment. The conclusions reached are as follows:

General Conclusions

"*Changes in Weekly Output.* — 1. In 87.2 per cent. of the establishments studied a reduction to a work week of 48 hours or less was accompanied by a decrease in weekly output per worker. In 8.7 per cent. of the plants the workers were able to maintain weekly output, and in a very few cases (4.1 per cent.) weekly output was increased.

"*Changes in Hourly Output.* — 2. In slightly more than two-fifths of those establishments in which weekly output was decreased, the same hourly output was maintained as under the previous schedule of hours, and the decrease was therefore approximately in proportion to the reduction in hours. In about one-fifth of the establishments which showed a decline in weekly output, hourly output was increased sufficiently to offset partially the loss in working time, and the loss in weekly output was therefore less than proportional to the reduction in hours. In one-sixth of the establishments suffering reduced weekly production there was a decrease in hourly as well as weekly output, or a decrease in weekly output greater than proportional to the reduction in hours. A number of establishments reported a decrease in output but did not report the extent of such decrease per worker.

"*Effects on Health and Contentment of Workers.* — 3. The board was unable to secure information which would warrant valid conclusions regarding the effect of the reduction in hours upon the health of the workers or upon the frequency of accidents. In most cases no change in the health of the workers was reported. It is interesting to note, however, that a number of the establishments in the various industries which either maintained or increased previous weekly production, reported better health among their employees, either as a result of the shorter hours or of improved working conditions.

"From the evidence contained in the replies to the questionnaire, it was impossible to reach any conclusions as to the effect of the reduction in hours upon the contentment of the workers. It is probable that in many cases the reduction in working time was at least a contributory factor in improving the contentment of the worker; but so many other factors also entered into the problem and in so many cases apparently completely counteracted the effect of the reduction in hours, that it was not possible to draw any definite conclusions in regard to the effect that the one factor, shortened hours, may have had in this regard.

"*Effects on Quality of Product.* — 4. On the whole, the quality of production was maintained. A very few establishments reported a better quality of production. In certain establishments, however, the speeding up by the workers to increase hourly output resulted in an inferior quality of goods, and in other

instances a general slackening on the part of the workers caused a decline both in quantity and in quality of output.

Effect of Other Factors on Output

"It was clearly evident in this investigation that a large number of factors beside the reduction in working time were involved in these changes in output. The findings of the investigation with regard to these collateral factors are summarized as follows:

"*Character of the Work.* — 1. The character of the work, *i.e.*, whether the process was largely handwork or machine work, for the most part determined whether or not it was possible for the worker to increase hourly output.

"In those industries, such as cotton manufacturing, where highly automatic machine processes predominated, the output was limited almost entirely by the speed of the machines. In practically every case a reduction in hours was accompanied by a decrease in output. In those industries, however, where handwork predominated in the manufacturing processes, or where the skill and speed of the operative in handling the machines were the controlling factors — such as in the boot and shoe industry or in certain kinds of metal manufacturing, and in certain miscellaneous industries — it was possible to increase the hourly output of the workers, in some cases to the extent of entirely compensating for the loss in working time or even exceeding the previous weekly production." — C. K. Drinker.

Making Time Studies Pay. *B. M. Maynard.* Factory, May 15, 1921, 26, No. 10, 1178–1183. — In this article the following eighteen betterments from time studies are discussed and the principles illustrated by specific examples:

1. Just standards of production.
2. Most efficient size of gang.
3. Efficient use of machines.
4. Subdivision of present operations.
5. Combination of present operations.
6. Efficiency of supplies and tools.
7. Economy in installing new machines.
8. Best shop practice.
9. Proper location of work and tools.
10. Reduction of fatigue.
11. Best design of tools, jigs, and fixtures.
12. Proper handling in previous operations.
13. Possibility of using wage incentives.
14. Setting price rates.
15. Arrangement of machines.
16. Getting equipment into balance.
17. Fitness of man to the work.
18. Check up faulty planning and management. — M. C. Shorley.

Health Education in Industry. *C. E. Ford.* Am. Jour. Pub. Health, June, 1921, 11, No. 6, 489–497. — The industrial health department can be made the strong right arm of the public health department. A part-time physician no longer suffices for a plant; it should have a capable, full-time man with special training covering the wide field outlined by the author in this and a previous paper. Emphasis is placed on the physician's duty to educate the employees in all matters relating to health in general and to the particular health factors of the industry. If industry can pay $2.50 per employee per year for health, the community ought to increase its health appropriations. — H. F. Smyth.

## SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

### CIRCULATORY SYSTEM

The Effort Syndrome together with a Consideration of the Significance of Certain Murmurs. *Alfred E. Cohn.* Mil. Surgeon, Feb., 1921, 48, No. 2, 186–198. — This paper is a brief summary of army experiences relating to cardiac efficiency.

It has proved desirable to reject individuals with a diastolic murmur, whether due to aortic insufficiency or mitral stenosis. Systolic murmurs, however, have caused much discussion and individuals showing such murmurs are now classified in accordance with their relation to certain other criteria: namely, (1) the size of the heart; (2) the history of infection, especially of rheumatism; (3) the intensity of the second sound in the second left interspace or third left costochondral junction; (4) the reaction to exertion.

Organic heart disease, with a systolic murmur, is readily managed if thoroughly analyzed, keeping these four features in mind, but func-

tional heart disease spoken of under the heading of "irritable heart" or "the effort syndrome," is far harder to classify. Cohn discusses the symptomatology of this condition and concludes with the following sentence: "The attempt has been made to show how involved the symptom complex is, and how it touches intimately other domains in medicine aside from cardiovascular. Its etiology cannot now be conscientiously indicated nor its exact relations to the numerous processes involved, which are familiar and the connections of which with this entity immediately suggest themselves."

The poorly defined nature of the condition described does not permit adequate treatment in a summary. Readers wishing a thorough discussion of a matter which is certainly of importance in industrial medicine should consult the original paper. — C. K. Drinker.

Exercise Tolerance of Children with Heart Disease as Determined by Standardized Test Exercises. *May G. Wilson.* Jour. Am. Med. Assn., June 11, 1921, 76, No. 24, 1629–1633. — The author reaches the following conclusions:

"1. The circulatory reactions after test exercises in forty-five normal children, and in 116 children with heart disease, confirmed the results obtained in the twenty normal children of the previous study, in all essential points.

"2. A working table was formulated of standardized test exercises followed by normal systolic blood pressure curves, without symptoms of dyspnea and fatigue. It was standardized from an analysis of the reactions of an average group of sixty-five normal children according to age, weight and height.

"3. The degree of distress and type of systolic blood pressure curve following standardized test exercises was used as a gage in estimating the exercise tolerance of children with heart disease.

"4. Of the seventy-one children having definite organic heart disease, without symptoms of insufficiency, 69 per cent. had a normal tolerance for standardized test exercises, 29 per cent. had a fair tolerance, and 2 per cent. had a poor tolerance.

"5. In children with chronic organic heart disease, exercise tolerance tests give important and useful information which may be utilized as a scientific basis for intelligent regulation of the child's activities. The observations resulting from this investigation would seem to indicate that the fear of exercise is unwarranted, and that a wider latitude may be permitted with safety." — C. K. Drinker.

## MENTAL

The Industrial Cost of the Psychopathic Employee. *Margaret J. Powers.* Ment. Hyg., Oct., 1920, 4, No. 4, 932–939. — Miss Powers gives us some very startling figures of a case (diagnosed as paranoid *dementia praecox*) covering a period of ten years, which is of interest because of the accurate record which the man kept of his activities and wanderings in search of congenial employment. His earnings for ten years amounted to $3,316.21. Using a very conservative scale, she has estimated that his charge on industry during the same period for cost of hiring, cost of training, wear and tear, reduced production, and spoiled work amounted to $3,608.50; his cost to society for a decent maintenance at $1,200 per year would be, roughly, $8,700. Miss Powers has done well to present these figures. They will succeed where generalities, rhetoric, and appeals to humanity fail. What we need is more figures, based upon undisputed facts.

Miss Powers quotes the United States Commissioner of Labor Statistics as saying that unemployment causes more slowing down of production, demoralization, and suffering than all other industrial mishaps, and that among the various causes of unemployment are the lack of an intelligent employment policy for hiring and handling men, the failure to gain the goodwill of employees, and the failure to make use of the tremendous latent force lying dormant in the workers. — Stanley Cobb.

## RESPIRATORY SYSTEM

Clinical and Experimental Observations on the Anaphylactic Bronchial Asthma of Workers in Furs. *H. Curschmann.* München. med. Wchnschr., Feb. 18, 1921, 68, No. 7, 195–197. — Several cases of asthma in men who work with furs dyed with ursol, a paraphenylene-diamine derivative, are reported to show the anaphylactic character of the disease. Numerous references are made to other discussions of the same disease. The work of Gerdon (abstracted in this Journal, May, 1921, 3, Nos. 1, 4 and 5, from the *Zentralbl. f. Gewerbehyg.*, Sept., Oct., and Nov., 1920) is summarized to show the experimental basis in guinea-pigs for the conclusion that this is true

anaphylaxis. Cases are reported where the use of calcium intravenously or by subcutaneous route has been successful as a prophylactic against attack, or in giving relief when administered after the onset of an attack. Desensitization by increasing doses of the dye seems of no use. It is proposed to try the calcium treatment by the inhalation of solutions of calcium salts in spray form. — E. L. Sevringhaus.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Permeation of Oxygen Breathing Apparatus by Gases and Vapors. *A. C. Fieldner, S. H. Katz,* and *S. P. Kinney.* U. S. Bur. Mines, Tech. Paper 272, Jan., 1921, pp. 24. — The investigators reached the following conclusions: "Tests were made to determine the permeability of the rubber bags of oxygen apparatus to gases and vapors. The breathing bags in vapor of volatile casing-head gasoline showed dangerous penetration; in one test 2.60 per cent. of gasoline vapor was in a breathing bag after fifteen minutes' exposure to air containing about 34 per cent. of casing-head gasoline vapor.

" . . . Tests lasted two hours, which is the time the larger oxygen breathing apparatus are designed to be worn. All the fabrics now used by the Bureau of Mines for breathing bags, excepting the Fleuss, proved permeable to gasoline and benzene vapors, and undoubtedly to other similar organic vapors. No permeation of the fabric investigated was found for carbon monoxide or natural gas. The impermeable (in two hours) Fleuss material consisted of heavy sheet rubber, one-sixteenth inch thick, made of high quality stock; no cloth was used in it.

"Fabrics made of two rubberized sheets cemented with a glue and glycerin mixture were found completely impermeable; one such fabric had a total thickness one-third that required for rubber. Special tests for resistance to rough mechanical treatment, exposure to weather, hot dry air, and freezing temperature were passed by this fabric without permeation or loss of flexibility. A fabric made of cloth impregnated and coated on one side with pyroxylin varnish allowed only a slight penetration of gasoline and benzene vapors toward the close of the two-hour test period, not enough to be dangerous. A slightly thicker coating would entirely prevent penetration. This fabric has apparently very desirable properties for use in breathing bags, and deteriorates less than rubber with age." — M. Dent.

A New Tubular Breathing Mask. *George O. Smith.* Safety Engin., March, 1921, 41, No. 3, 106–107. — A new mask which seems to meet all requirements for work in poisonous gases has been devised by the Atmos Corporation. The new feature of this mask is the oxygen injector by which the range of service is extended 100 feet without increasing the resistance to inhalation in the mask. "The mask may be used with safety in all industrial work where smoke, dust, furnace gases or other noxious fumes exist . . . and is now in successful use in industrial plants and by public utility companies." — M. Dent.

Medical Decisions in Cases of Industrial Poisoning. *F. Curschmann.* Zentralbl. f. Gewerbehyg., March, 1921, 9, No. 3, 54–61. — *III. Psychic Disturbances in Connection with Poisoning by Aromatic Hydrocarbons.* — A man was overcome by fumes of dinitrobenzene, and the marked anemia which followed had not returned to normal after more than a year in spite of treatment. Two and a half years later, mental excitement became noticeable in addition to the continued weakness, and soon attacks of mania followed. The continued anemia is considered as demonstrating the essential chronicity of the poisoning, and therefore as justifying the inclusion of this case in the group of cases with damage to the central nervous system from chronic poisoning with aromatic nitro-compounds.

*IV. Respiration of Furnace Gases as a Cause of Death.* — A young man who had suffered from severe organic heart disease with an attack of decompensation was employed at a furnace and was in general good health. Near the end of a night shift he breathed a large amount of furnace gas. About twelve hours later he died, following weakness, head pains, cyanosis, and signs of cardiac dilatation and acute pulmonary edema. It is considered as probable that the cardiac disease made him more subject to the damage from the gases, but the furnace gas was the immediate cause

of death, through the effect of the carbon monoxide on the blood and of the sulphur and cyanogen derivatives on the lungs.

*V. Aniline Poisoning and Tuberculosis.* — A young woman who was well and robust was employed in making explosives. After a few weeks she had an acute attack of poisoning with a nitro-compound, followed a few weeks later by a second attack. At this time she was found to have an active apical lesion, and seven months later she died from pulmonary tuberculosis. The claim for industrial compensation is supported on the ground that the anemia and poisoning may have made possible the breakdown of an old and quiescent lesion of tuberculosis, which was followed by an accelerated course of the disease. — E. L. Sevringhaus.

GANGRENE FROM GAS POISONING. *Laignel-Lavastine* and *Alajouanine*. Abstracted as follows from Bull. et mém. Soc. méd. d. hôp. de Par., April 15, 1921, 45, No. 12, 484, in Jour. Am. Med. Assn., June 4, 1921, 76, No. 23, 1616.—"About three weeks after severe poisoning with illuminating gas, the man developed gangrene of the foot and phlegmasia alba dolens, with final recovery." — C. K. Drinker.

INDUSTRIAL LEAD POISONING. *Marvin D. Shie.* Jour. Am. Med. Assn., March 26, 1921, 76, No. 13, 835–842. — This is a most excellent brief review of the subject. The author's conclusions are as follows:

"Certain signs and symptoms of plumbism have been given somewhat more importance as diagnostic points than they deserve. These are anemia, basophilic degeneration of the red cells, hypertonus and constipation.

"Pronounced anemia is present in only relatively few cases; in many cases there is no anemia whatever. The pallor that is usually present is therefore due to some other cause — possibly a constriction of the peripheral blood vessels. Basophilic degeneration of the red cells is rare in chronic cases, and its value as a diagnostic point, even in acute cases, has probably been overrated.

"The presence of hypertonus is extremely variable. Among a group of pottery workers exposed to lead dust, there was practically none; but among a group of lead refiners exposed to lead fumes, it was present in nearly every case. The cause of this variance is unknown; however, the difference in the form of the lead to which the different groups are exposed may have something to do with it. Hypertonus is nearly always present during attacks of colic.

"Although constipation is usual, it is not invariably present. The assumption, therefore, that a patient who is not constipated does not have lead poisoning is fallacious. Many cases of plumbism — especially acute cases — occur without constipation.

"A point of diagnostic value, which appears to have escaped recognition except by Hayhurst, is the presence of mononucleosis in chronic cases. This is almost invariably present.

"The presence of a lead line is also extremely variable. In my series it was present in about 90 per cent. of the cases. Other investigators have sometimes found it present in not more than 20 per cent. of their cases. This difference, like that in the case of hypertonus, may possibly be due to the difference in the form of the lead in which the patients were exposed.

"In the treatment of plumbism, prophylaxis is of much more importance than the curative treatment. By means of proper working conditions and medical supervision on the one hand, and the observance of the rules of personal hygiene and common sense, on the other, together with co-operation between employers and employees, the incidence of plumbism in American industries could be greatly decreased. Proper compensation for occupational diseases is a necessity, and would help to decrease both the incidence and the severity of lead poisoning.

"If the cause of the poisoning is removed, the prognosis, except in a few cases, is good even without medical treatment. If, however, the lead continues to exert its deleterious effects through small, steady doses, the case steadily progresses, finally terminating in some form of paralysis or in some of the common degenerative diseases. As a rule, lead poisoning is a disabling rather than a fatal disease, although in chronic cases it undoubtedly hastens death.

"Vital statistics of all occupational diseases, including lead poisoning, are very incomplete. Rapid progress by state or federal agencies in the devising of methods for the prevention or cure of all such diseases cannot be made unless there is prompt and complete reporting of all cases." — C. K. Drinker.

OCCUPATIONAL LEAD POISONING. *W. H. Rand.* U. S. Bur. Labor Statis., Month. Labor Rev., Feb., 1921, 12, No. 2, 135–148. — The author deals with his subject under the follow-

ing main headings: portal of entrance into the body; clinical signs and symptoms; prevention of plumbism. — R. B. Crain.

Report of the First Course on Prophylaxis of Lead Poisoning for the Plant Physicians of the German Lead Color Industries. *L. Grobe.* Zentralbl. f. Gewerbehyg., March, 1921, 9, No. 3, 52–54. — A series of lectures, laboratory demonstrations, and conferences was arranged by the lead industries, and given under the direction of Dr. P. Schmidt, at Halle. Clinical and scientific aspects of the problem were considered, and the unsolved problems in early diagnosis and prophylaxis were discussed. The group visited a nearby plant to observe the mechanical and personal means of prophylaxis against lead poisoning. The conference will probably become an annual event in Germany. — E. L. Sevringhaus.

The Symptoms of Acute Chromate Poisoning. *H. Brieger.* Ztschr. f. exper. Path. u. Therap., Nov. 12, 1920, 21, No. 3, 393–408. — A number of cases of chromate poisoning were observed, which arose from the use of a salve made up with potassium chromate by mistake. Where it was applied, the skin became necrotic, and sloughed; death resulted from the infection of the exposed areas in some cases. About one and a half hours after the application of the ointment, the pulse became very weak and thready, and markedly dicrotic. Clinical examination of the heart was negative, but at autopsy even the early cases showed fatty degeneration. The blood pressure did not fall, as in previously reported cases. Localized areas of cyanosis appeared on the skin.

An acute nephritis with much albumin and oliguria gradually gave place to a subacute form with polyuria and nitrogen retention, which finally disappeared in the cases which survived long enough. There was no edema. The anatomical changes consisted of hyperemia and tubular necroses. The glomeruli were little altered.

The blood showed an intense, almost leukemic hyperleukocytosis, the white count in one case reaching 41,900, with immature polymorphonuclears, myelocytes, and myeloblasts notably increased. The red cell count was not markedly lowered and a hydremia was suspected. Nucleated red cells and Howell-Jolly bodies were seen. The platelets were increased in one case to 421,000, and giant platelets were seen. The clotting time was unchanged.

Vomiting was an early symptom, and at autopsy the gastric mucosa was hyperemic. No constant changes were seen in the central nervous system. In one case, fourteen days after exposure to the poison, chromate was found in the body fluids in the following amounts: blood, 2 to 5 mg. per 100 c.c.; urine, 8 mg. per liter; stool, 0.61 mg. per 100 gm.; stomach contents, 0.63 mg. per 100 c.c.

The fate of the patient depends on the onset of diuresis. To hasten this, caffein and other cardiac and renal stimulants were given. Bleeding and infusion of glucose solution were tried. Decapsulation of the kidneys did not seem effective. Pohl advises alkali therapy. The affected skin should, of course, be cleared of the poison as completely as possible.

Extensive references to previous articles are given. — T. J. Putnam.

## DUST HAZARDS AND THEIR EFFECTS

Experiments in Control of Air Dustiness. *O. M. Spencer.* Nation's Health, May, 1921, 3, No. 5, 307–309. — This article deals with the results of some recent studies made by United States Public Health officers of air conditions prevailing in certain occupations and having a tendency to cause tuberculosis. It is well known that certain occupations tend to produce fibroid changes in the lungs. Two standard types of air purification are in common usage today: wet grinding, and dry grinding under an exhaust system. Contrary to common belief, the latter is the most effective. The control of air dustiness in industry calls for: (1) the establishment of a "standard dust table" of the number of particles of a certain size permissible in all dust-creating occupations; and (2) the checking of the efficiency of all dust-removing systems at regular intervals by an actual dust count.—L. A. Shaw.

Dust in Expired Air. From Foreign Letters, Jour. Am. Med. Assn., May 14, 1921, 76, No. 20, 1360. — "In a letter to the *Lancet*, Dr. J. S. Owens, an authority on atmospheric pollution, has reported some experiments of great importance, as they traverse the current

teaching that the air passages are an efficient trap for the removal of matter suspended in the inspired air. Tyndall stated that expired air is optically pure, and it is generally assumed that air entering the lungs through the nose is purified from all suspended matter before it reaches the deeper part of the lungs. Having some doubts as to this assumption, Dr. Owens made experiments. He tested a sample of air during a slight smoke haze in November in London, and found that it contained 1.92 mg. of suspended matter per cubic meter. He then filled a small rubber balloon with ordinary tidal expired air, taking care that the balloon was washed out by filling with expired air and emptying several times. It was found to contain 1.28 mg. per cubic meter. Thus, in ordinary breathing the expired air contained about 70 per cent. of the suspended impurity which entered during inspiration. Doubtless some of the suspended matter in the expired air was deposited on the walls of the balloon, but this would not affect the result much. A similar experiment was then made with 'reserve air.' The balloon was thoroughly washed out with reserve air and then filled after the end of a long inspiration. The reserve air was found to contain about 60 per cent. of the dust of the inspired air. These observations were checked by using an apparatus by which a jet of air 1/1000 inch in diameter can be blown on a microscopic slide at a distance of 1/16 inch. The result is that a certain proportion of the suspended particles strike and adhere to the slide. A few cubic centimeters of ordinary London air thus produce a black spot visible to the naked eye. Expired 'tidal' and 'reserve' air yielded a black spot. Ordinary London air yielded particles which were all black and varied in diameter from 1/100000 to 1/20000 inch. Expired air yielded similar particles." — C. K. Drinker.

Dividends from Collecting Dust. Factory, March 1, 1921, 26, No. 5, 608–612. — There are many reasons for giving attention to the dust problem in industry. Dust causes terrible explosions, it is a menace to health, it injures machinery and increases fire risk. Adequate protection can be secured only by a dust collecting system.

All industrial plants are dusty; only actual dust tests at the plane of work show the degree, and only by determining the composition of the dust and interpreting the results with reference to standard tables that ought to be worked out for the various industries can the unhealthfulness of any particular process be determined.

Experiments carried out by the Bureau of Mines have shown that in the case of coal dust the density necessary for explosion is 0.025 ounces per cubic foot of air, and this density may be taken as a critical density for any of the carbonaceous dusts. Not all dusts will explode, but the dusts from any material which burns or is readily oxidized will explode under certain conditions, and it can be said that, in general, the finer the dust and the lower its moisture content the more rapidly ignition takes place, or the greater the danger of explosion. To prevent explosions, therefore, it is necessary not only to eliminate sources of ignition, but to keep the plant clean and free from dust.

Where entire units of a factory are exposed continually to dust, a dust-collecting system should be installed which has a capacity of supplying every man in a unit with 25 cubic feet of air every minute, and when possible the dust should be taken into the dust-collector without being allowed to escape into the air. For this purpose special intake hoods for every machine are usually necessary.

As to the results, one installation, it is claimed, has had the effect of reducing absence of employees 85 per cent. A better day's work is obtained from the employees, and more harmony and satisfaction prevail. Clark, who reported this case, says that a study of carefully collected data proves that death rates have been reduced from 60 to 50 per cent. by introducing good ventilating and dust-collecting systems in dusty plants.

A dust-collecting system, if correctly designed and properly installed, will in all cases effect a saving. The initial cost is not great, there is practically no expense for maintenance, and the cost of power for operating a fan is slight.

The paper contains further useful information in regard to dust explosions, and should be read in detail by anyone who is interested in this subject. — G. E. Partridge.

The Removal of Dust from Rag-Tearing and Rag-Beating Machines. *Morgner*. Zentralbl. f. Gewerbehyg., March, 1921, 9, No. 3, 65–69. — The use of such machines in the textile industries has grown markedly during the

war period. Diagrams of the machines are explained. The dust is removed by centrifugal fans and the dusty air is carried to dust chambers for sedimentation. Ventilation of the rooms is not a desirable method of dust control. The necessity for tight and smooth air piping from the fans is emphasized. — E. L. Sevringhaus.

Dust in the Bootmaking Industry. *P. Sardi.* Il Lavoro, Feb. 28, 1921, 11, No. 10, 289–290. — The author analyzed the dust which arose from various processes of bootmaking into its various contents of water, fat, soot, tan, etc. — M. Dent.

A Roentgen Study of Dust Inhalation in the Granite Industry. *D. C. Jarvis.* Am. Jour. Roentgenol., May, 1921, 8, No. 5, 244–258. — The author concludes as follows:

"1. Film densities are influenced by mouth breathing, nationality and occupational position.

"2. The machinery must be considered as a source of dust as well as the material being worked.

"3. A standard exposure technique should be adopted as early as possible in a study of dust inhalation in order that one may feel sure of variations of density.

"4. While classification of films is helpful, the lung lesion in a dust worker is like the shifting sand of the sea and each film should be judged by its own individual densities as portraying the pathology in the making in that particular individual.

"5. Evidence tends to show that the lesion always remains peripheral and the lung reaction to an irritant is evidenced by densities appearing from the hilus outward.

"6. It seems possible to parallel films of tuberculosis, pneumonia and various other pathological conditions of the lungs with the films of granite cutters, there being an absence of clinical activity in the latter, the mechanical irritant producing the same lesion as a bacterial one.

"7. It would seem that many densities are being diagnosed as tuberculosis which should be considered as densities of pneumoconiosis." — C. K. Drinker.

Breathing Rock Dust. Abstracted as follows from U. S. Pub. Health Service, Health News, Nov., 1920, in Physiol. Abstr., Jan., 1921, 5, No. 10, 467. — "A recent survey shows that over 200,000,000 tiny particles of dust, as sharp as ground glass, are breathed into the lungs and air passages with every cubic foot of air in some of the factories in the United States. Such dusts breathed into the lungs are never expelled. Photomicrographs show the particles to be exceedingly sharp and jagged, and chemical tests prove them to be insoluble. Work under such conditions invites respiratory diseases and makes a real health hazard. As a result of the survey, industrial hygiene engineers devised means for removing the dust from the air and minimizing hazards from fumes and poisonous gases. In spite of the fact that the installation of such devices was expensive factory managements immediately put them to use." — McKeen Cattell.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Bacterial Content of Telephones with Special Reference to Respiratory Pathogens. *C. C. Saelhof.* Abstracted as follows from Am. Jour. Hygiene, March, 1921, 1, No. 2, 234, in Jour. Am. Med. Assn., April 16, 1921, 76, No. 16, 1127. — "Hemolytic streptococci were isolated by Saelhof in 15.9 per cent., the diphtheria bacillus in 2 per cent., and the pneumococcus in 1 per cent., from the transmitters and receivers of ninety-four telephones. Of eleven strains of hemolytic streptococci isolated 90.0 per cent. were virulent for rabbits. Saelhof urges that sterilization of telephones should be practiced to prevent the spread of virulent organisms. Cleansing with soap and warm water and subsequent sterilization in mercuric chlorid, compound solution of cresol, etc., for a period of ten minutes, is recommended. In speaking, the mouth should not come in direct contact with the transmitter. The public should be taught how to use the telephone hygienically." — C. K. Drinker.

Examination of Food Handlers from Standpoint of Tuberculosis. *M. J. Fine.* Mod. Med., March, 1921, 3, No. 3, 197–198. — This article details the policy of the city of Newark, N. J. in the matter of food handlers.

Employees are allowed to handle food only after securing a health certificate. The physical examination includes a personal history, Widal test, culture for diphtheria from nose and throat, vaccination, Wassermann on suspicious evidence, inspection for mucous patches in nose and throat, rashes, etc., on the skin, and of genitals in males for gonorrhea and syphilis, besides the usual lung tests for tuberculosis. Sputum specimens are required on suspicion and further examination at later date by a special bureau.

The reaction of the individual to this health requirement is so varied that statistics do not clearly indicate existing conditions. Twenty active tuberculous cases have been found and denied work as food handlers. Early diagnosis is beneficial to the individual and the protection from contagion is equally so to the public. Education in health measures is of no small benefit to the whole community. — Elinor D. Gregg.

Miners' Consumption in the Mines of Butte, Montana. Preliminary Report of an Investigation made in the Years 1916–1919. *Daniel Harrington* and *A. J. Lanza.* U. S. Bur. Mines, Tech. Paper No. 260, Feb., 1921, pp. 19. — Recent investigations in regard to miners' phthisis in the United States and England have revealed the following facts: "(1) that the so-called miners' consumption or miners' phthisis is produced by the mechanical irritation of the lungs by particles of dust of rock containing free silica; (2) that dust is dangerous in proportion to the amount of free silica or other hard, sharp, insoluble material it contains; and (3) that the particles of dust small enough to enter and remain in the lungs measure less than 10 microns, or 1/2500 of an inch in longest dimension."

The results of the physical examination of 1,018 miners in the Butte mines showed that, out of 432 cases of miners' consumption, 44.9 per cent. were in the early stages; 29.6 per cent. moderately advanced, and 25.5 per cent. far advanced; 77.3 per cent. of these cases had worked more than five years in Butte mines.

The investigators make the following recommendations for guarding against miners' consumption:

1. Dry drilling should be absolutely eliminated. Spraying devices used with dry drills are very likely to be inefficient. "Elimination of dry drilling is largely a question of drilling fewer upper (practically vertical) holes; wet drills (Leyners and wet stopers) can be readily employed in the drilling of all holes except those pointed vertically upward or not more than 30° from the vertical."

2. All working places underground should be piped with pure city water under pressure. Water should be used to spray the mouths and possibly the entire length of ore chutes; skip chutes should be sprayed as well; where dry ore is handled in downcast shafts a complete system of water sprays should be used in air courses leading from the shaft; and water should be used in sprinkling the floors, sides, and top or back of haulage ways, shaft stations, and manways at all times of the year.

3. Elimination of firing of shots when the shift is at work. The shock to the air from the firing of shots throws clouds of excessively dangerous dust into the air.

4. Special effort should be made to increase the ventilation of the mines. Air currents should be concentrated, should flow through the working places with minimum hindrance, and then be discharged from the mine as quickly as possible.

5. Underground men coming from the mine in winter should not be exposed to the air in their wet clothing in order to give their time. Some other arrangement should be made. — M. Dent.

Anaerobes in Hair Dust. *R. M. Buchanan.* Jour. State Med., May, 1921, 29, No. 5, 149–151. — In the course of a search for anthrax in hair used for industrial purposes, it was found that anaerobes causing gangrenous lesions were present very frequently. Among those recognized were: *B. perfringens*, *B. edematis maligni*, *B. sporogenes*, *B. histolyticus*, *B. edematicus*, *B. fallax* and *B. putrificus*. — Barnett Cohen.

Hookworm in California Gold Mines. *R. W. Nauss.* Am. Jour. Pub. Health, May, 1921, 11, No. 5, 439–451. — In 1916–1917, the author conducted a detailed investigation of soil infestment in various mines of California and of hookworm infection among miners, with a view to the control and ultimate eradication of the disease. He obtained the following results:

"Endemicity of hookworm infection in mines is dependent not only on favorable conditions of temperature, relative humidity, mine drainage and chemical character of mine

drain water but also on the particular circumstances and conditions existing relative to mine pollution and ova-laden feces.

"The use of mine water catchment devices and storage tanks, reservoirs, etc., to receive the evacuations of men while underground, may be responsible for a high incidence of ankylostomiasis among workers.

"Nematode larvae, resembling hookworm larvae morphologically, were isolated from mine soil in a certain cross-cut in mine 'A', and it was proved subsequently by infection of puppy-dogs in this same locality that hookworm larvae capable of development into adult *A. duodenale* were actually present in the mine soil.

"Ankylostomiasis among California miners has centered largely in a few of the deepest gold mines situated along one section of the 'Mother Lode' in Amador County.

"Surface infection did not exist in the vicinity of 'Mother Lode' mines since practically all cases of ankylostomiasis discovered among surface workers were traceable to contact in mines with infected mine soil or drain water." — H. F. Smyth.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Trauma as Factor in Skin Disease. *E. Aievoli.* Abstracted as follows from Riforma med., March 19, 1921, 37, No. 12, 271, in Jour. Am. Med. Assn., May 28, 1921, 76, No. 22, 1539. — "Aievoli discusses this subject from the standpoint of workmen's compensation. He comments on the difficulty of excluding malingering, and expresses approval of the German law which compels the insured to enter a hospital for treatment when the results of any trauma are exceptionally prolonged. If the insured declines to go to the hospital, the indemnity is reduced. When the French took command of Alsace and Lorraine they kept this law unmodified, although there is nothing of the kind in the rest of France." — C. K. Drinker.

Industrial Dermatosis among Printers. *W. J. McConnell.* U. S. Pub. Health Ser., Pub. Health Rep., May 6, 1921, 36, No. 18, 979–989. — Ink poisoning, affecting the parts of the arms and hands that are much in contact with inks is common among printers. The condition is attributed by foreign writers to the substitutes for pure oil of turpentine or its adulterants which are often used in cleaning. Inquiries made in this country among printing and engraving firms showed that dermatosis like that described by foreign writers occurs when no such substitutes or adulterants are used, and an investigation was therefore undertaken by the United States Public Health Service to obtain further information.

The investigation was made in one plant only, since the processes seemed to be the same everywhere, and it included observation of methods of work, physical examination of cases, analysis of materials, observation of methods used for removing ink from hands and arms, treatment of cases, and experimental work on volunteer subjects. It was found that there is constant contact with ink, especially in work on hand presses, and that in general very harsh methods are used in cleaning; the parts usually are first immersed in a mineral oil, and then soap and hot water are applied and often pumice soap and fine sand or perhaps a stiff brush. Examination of cases soon showed that all persons affected had dry skin, that is, lacking in natural oiliness. Experiments were made on a number of persons, some having dry and some oily skin. The ink was applied and allowed to remain, but produced no irritation; nor did the cleaning oil applied in the same way. But in another series of experiments, in which the ink was removed each night with soap and water and a brush, irritant action was produced. This was caused sooner, and the condition became more severe in those having dry skin than in those having oily skin. Still other experiments, in which either ink or cleansing oil was applied to abraded surfaces, showed that, although ink retarded healing, the oil did not.

Treatment of dermatosis was attempted by the application of calamine paint, the following prescription (for the use of which rules are given) being used: zinc ore (calamine and a silicate of zinc) pulverized and passed through a 100-mesh sieve, 3 parts; gelatine, 4 parts; glycerine, 5 parts; water, $6\frac{1}{2}$ parts. As a general measure directions were given to apply lanolin before going to the press room, to wash at the lunch period, using a mixture of sawdust and green soap, then apply lanolin again

before going to work. The skin lesions responded readily to the treatment, and it is affirmed that if the prophylaxis recommended is used, dermatosis will be prevented. — G. E. Partridge.

Dermatitis among Workers in Cane. Il Lavoro, Jan. 31, 1921, 11, No. 9, 274–275. — From the macerated cane stalk comes a black dust which, on contact with the skin, is capable of producing dermatitis of the forehead, cheeks, eyelids, nose, and lateral parts of the neck, back of the hands, and scrotum. The conjunctiva is involved in this malady, giving rise to hyperemia, photophobia, and lacrimation, and sometimes the nasal mucous membrane is affected, and in grave cases frontal headache occurs. Workers affected with the disease complain of itching, burning, and slight pain.

The disease is due to the chemical action of the black powder which is found in the stalks of old cane. Cure consists in rest and application of ointment to the parts affected. — M. Dent.

Concerning the Occupational Disease of Reapers and Winnowers. *G. Gherardi.* Il Lavoro, Jan. 31, 1921, 11, No. 9, 257–262. — This disease is an infection of the cornea produced on the corneal epithelium by the sharp points of rice leaves which are blown about during the processes of reaping and winnowing. The evil is a very real one in the rice-growing districts. Of the infected cases 10 per cent. suffer total loss of vision, 43 per cent. suffer diminution of vision, and 41 per cent. recover. The author suggests that glasses would help in prevention work, and that first-aid stations should be established near the fields. — M. Dent.

Ammonia Burns of the Cornea. Am. Jour. Ophth., March, 1921, Series 3, 4, No. 3, 210–211. — This paper reports eight cases of burns of the cornea caused by ammonia scattered by a bursting ammonia cylinder. The four patients with first degree burns recovered quickly with one treatment of cocain, followed by boric solution and oil of ricini every four hours. Two others died before the cornea began to slough. One patient recovered with clear cornea after ten days, and the other sustained very deep sloughing of the cornea with marked scarring. He was in the hospital 120 days. In discussing these cases, it was suggested that cocain should not be used and that hot compresses increased the vitality of the tissues and diminished local pain. Sterile olive oil is preferred by some to castor oil. It is very difficult to determine the depth of the burn owing to the penetrating character of the caustic. — Elinor D. Gregg.

Fluoroscopy for Ocular Foreign Bodies. *W. S. Franklin, F. C. Cordes,* and *W. D. Horner.* Am. Jour. Ophth., Feb., 1921, Series 3, 4, No. 2, 123–124. — Although X-ray localization has greatly simplified the removal of foreign bodies from the orbit and globe, there are cases in which that method, for one reason or another, fails to give a correct localization. The improved Sweet localizer is said to be accurate to a fraction of a millimeter, but in eyes having a high degree of myopia or hyperopia the method becomes unreliable. In some cases surgical exploration is necessary. In such cases, and whenever there is doubt about the location, the fluoroscope is a very useful adjunct, provided the foreign body is large enough to be seen readily under the screen. — G. E. Partridge.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Safety and Accident Prevention. *Fred G. Lange.* Indust. Management, April 1, 1921, 61, No. 7, 257–259. — With the passing of a state compensation law in 1911 figures indicating the actual extent of accidents showed the need for adequate and uniform safeguards against industrial accidents, and at the same time furnished the incentive to employers to seek means of reducing hazards in order to avoid prohibitive accident costs. Scientific and uniform standards are important because employers will no longer hesitate to provide guards which they know are necessary and which will be permanent if installed according to specifications. One of the principal sources of accidents is the worker himself. Carelessness and ignorance conspire to cause him injury. As an outgrowth of this movement to educate the worker the "school safety" movement developed, with the object of giving children a knowledge of accident hazards and means of avoiding them.

Engineers have now begun to realize the importance of the possibilities of preventing accidents through fundamental changes in structure, layout, or operation. The pioneer days when an employer might spend thousands of dollars for safety without any returns are now over. Accident prevention has become a routine affair — the application of known solutions to known problems. — L. A. Shaw.

Reducing the Cost of Industrial Accidents. *M. R. Lott.* Factory, May 1, 1921, 26, No. 9, 1080–1083. — This is an account of the safety work in a plant employing about 2,000 men in the making of scientific apparatus. A full-time engineer was engaged to investigate the safety problem and to conduct an educational campaign. As a result accidents have been reduced to an average of less than one a month among a thousand men, the severity has been decreased 93 per cent., and the cost of compensation 96 per cent. "These results were made possible through a carefully planned organization, systematic methods for carrying on the work, and a carefully selected personnel to whom duties could be assigned." The hospital takes care of minor surgery and all first aid. Educational bulletin boards are used, and talks are given to the men at noon-hour, or just before closing time. The plant is inspected by a committee of three every month. By having all cases requiring first aid report to the hospital, instead of using first-aid boxes, many cases of infection from small cuts and abrasions have been prevented. Careful and systematic recording of all necessary data is carried out, cases involving loss of time are immediately followed up by the safety engineer, and a nurse or physician is in constant attendance during factory and office working hours. All cases of absenteeism are investigated by the nurse. The yearly costs of the system, which include compensation payments, medical supplies, salaries, rental charge, interest, and depreciation, amount to from 7 to 10 per cent. of the annual payroll.

Records kept by the department show that the prevalence of illness means a higher accident rate. During the absence of the physician, when minor illness was not treated, there was a rise in the number of accidents. Of all cases treated, 46.3 per cent. were minor accidents, and 53.7 per cent. sickness cases. Of the accidents, 36.7 per cent. were due to the machinery operated; 25.2 per cent. to hand tools; 24.5 per cent. to carelessness in handling materials; 13.6 per cent. to miscellaneous causes, such as falling against benches and desks, etc.

Curves showing monthly variations in lost time and cases treated for sickness and accident are shown, and there are some reproductions of record cards, etc., used in the work. — G. E. Partridge.

How an Electrical Company Cut Accidents 78 Per Cent. *W. P. Strickland.* Nat. Safety News, May, 1921, 3, No. 15, 10. — In 1913 the New York and Queens Electric Light and Power Company began a series of monthly educational talks on safety, and organized and expanded its safety work, with the result that the accidents reported have decreased 78 per cent. A centralized safety bureau is maintained from which constant inspection is made of the whole system. A schedule is followed, by which every man attends a safety-first lecture and resuscitation drill once a month, and there is a monthly meeting of superintendents and foremen where safety construction is discussed. Prizes are given quarterly for the best suggestions for the prevention of accidents. A statement of accidents is distributed monthly, showing the number of accidents occurring in the respective departments. Accidents have been grouped, analyzed and discussed with the men, and remedies have been found in ten of the groups, so that they have practically eliminated accidents.

The resuscitation drills are especially thorough. Suspended animation from electric shock is far more serious than that produced by asphyxiation and drowning, and it has been found that the Schaefer prone pressure method is better than any other mechanical means of producing artificial respiration, especially if counter-shock, such as a violent blow on the jaw or hitting the soles of the feet, is used with it. In six cases resuscitation was effected by dropping the body and striking the feet. — G. E. Partridge.

How Accidents Are Prevented in our Foundry. *W. H. Steele.* Nat. Safety News, May, 1921, 3, No. 15, 25. — In the foundry of the Locomotive Stoker Company of Pittsburgh, Pa., which has an average daily pour of 40 tons of soft grey iron and 3 tons of bearing bronze, all moulding is done by machines. Statistics show that hand labor causes 40 per cent. more

accidents than does machine work — a fact which is confirmed by the experiences of this foundry. During 1920 there were but 201 cases requiring treatment, of which twenty-one were major accidents (that is, those requiring the attention of a surgeon); and during five years there has not been a fatal accident, nor one causing any form of permanent disability. This good record is due in part to the safety work, which has included careful individual attention in the fitting of goggles and provision of corrective lenses when required, and a thorough weekly inspection of machinery, a written report of the results of which are sent to the master mechanic. — G. E. Partridge.

Safe Clothing Reduces Burns of Steel Workers 50 Per Cent. Nat. Safety News, March 28, 1921, 3, No. 13, 8. — In the plant of the Cambria Steel Company all men engaged in pouring or handling in any way molten metal are required to wear fireproof leggings, aprons, and head and eye protectors, with the result that burns have been reduced 50 per cent. A campaign for safe clothing began in this plant with the provision of shoes that would protect from falling objects. These were bought by the company and supplied to the men at cost. Later, leggings, asbestos gloves, fireproof and waterproof clothing, one-piece overclothes, masks, aprons, helmets and shields were distributed on the same plan. The workmen have co-operated by suggesting improvements and by taking a general interest in the elimination of hazards. — G. E. Partridge.

What Is Safe Clothing for Factory Workers? *J. J. Lamb.* Nat. Safety News, March 7, 1921, 3, No. 10, 5-6. — Safe Practices Pamphlet No. 16, issued by the National Safety Council, is mentioned as a source of detailed information on the problem of clothing in its relation to safety, only the main points of which are touched upon in the present paper.

Loose or torn sleeves and torn trouser legs cause thousands of serious accidents every year, and there should be persistent effort to eliminate this risk. Proper clothing for the average workman consists of reasonably snug overalls and jumpers, or, preferably, a one-piece suit.

Injuries to the feet, resulting from accidents, constitute one of the most troublesome kind of accident, and they are especially prevalent in foundries where one-sixth of all injuries are attributed to defective and unsafe footwear. Laced shoes, which are hard to remove in an emergency and are also not sufficiently proof against the entrance of hot metal, are not nearly so good as "congress" shoes. The wearing of easily removable leggings is an added protection, as is also the reinforcing of the toes of shoes to protect the feet against heavy falling objects. Linemen and other electrical workers need specially constructed rubber shoes, and should wear stockings of non-conductive material. In some industries, leggings are necessary parts of safe clothing. A flare at the bottom to protect the instep is invaluable to men working about hot metals, liquids, and acids. Most industrial leggings have spring steel frames which fit closely to the legs, and have flaps that fold under the leggings in the back.

The essential points about aprons are that they should not be worn near moving machinery; that unless made of fireproof material they should not be worn near fires; and that waste should not be carried in the pockets. Caps have their uses — for cleanliness if for no other purpose. Transparent visors are good, but certain conditions require that these be non-inflammable. Helmets are to be advocated for such work as steel construction in shipyards, etc.

Gloves are one of the safety man's hardest problems. They are a serious hazard if worn about moving machinery. Hand leathers so fastened as to be readily released are suitable for some kinds of work. A good fastening is a coil spring attachment covered with leather. For operating machinery in very cold places, loose mittens with only three fingers — one for the thumb, one for the forefinger, and one for the other three fingers — are useful. Properly tested rubber gloves, kept sealed and dated until issued for use, are necessary for electricians. They should be kept in a fairly cool temperature and tested every six months. Gloves in use should be tested at least once a week.

In many plants, it has been found that workmen can be persuaded more easily to wear safe clothing, if the plant has a store where such clothing can be obtained at cost. — G. E. Partridge.

Safe Clothing for Chemical Workers. *Ira V. Kepner.* Nat. Safety News, March 14,

1921, 3, No. 11, 7, 10. — No one type of clothing can be provided for chemical workers as the hazards in each branch of manufacture are different, and clothes considered safe in a sulphuric acid area would be dangerous in a plant manufacturing lead oxides, nitro or amido compounds. A detailed outline is herein given of the various kinds of clothing which are necessary for protection against burns, poisonings, etc., in the diverse operations of the chemical industry. — Elinor D. Gregg.

Hip Length Leggings Protect Pourers in Foundry. Nat. Safety News, March 21, 1921, 3, No. 12, 14. — A description is given of the canvas hip legging in which pourers have worked 12,871 hours with no accidents. The legging is not tight, but hangs straight so that there are no wrinkles to catch iron should any splash. Thorough safety training also helps to keep up this excellent record of the Saginaw Products Company. — Elinor D. Gregg.

Safe Clothing for Women Workers. *Nesta Edwards.* Nat. Safety News, March 21, 1921, 3, No. 12, 7, 10. — Improper clothes help to cause fatigue. Nine-tenths of accidents are due to carelessness which is a result of fatigue. Shoes, hair, and jewelry generally play some part in every accident.

Safe clothing for women workers includes comfortable shoes with a broad heel affording sufficient base, be it low or high; shoe laces well tucked in; an attractive light-weight cap covering the hair; coveralls or overalls, and no jewelry.

Time and place to change clothing are essential. It takes a bit of tact to make safe clothing popular in factories, but it can be done if the employer is willing to go half-way on the expense involved, and if the uniforms are made as attractive as possible. They should only be required when necessary about machinery. — Elinor D. Gregg.

National Safety Code for the Protection of the Heads and Eyes of Industrial Workers. Bureau of Standards Handbook Series, No. 2. 1921, pp. 64. — General safety requirements are stated and operations are classified in nine groups, according to the objects against which protection is necessary. Protector, goggles, face mask, helmet, hood, and shield are carefully defined, and general directions are given in respect to selection of lenses, etc. In the following sections protectors for nine different groups of operations are described and specifications and tests are given. The final section of the code deals with operating rules — that is, sterilization, supply and fitting of goggles, replacement, inspection, tests for frame and glass, etc.

The second half of the handbook contains a discussion of the rules. The need for definite requirements to protect the eyes of industrial workers is shown by the fact that in 1918, in the state of Pennsylvania alone, there occurred 705 industrial accidents resulting in the loss of one or both eyes. The Pennsylvania Railroad has an active safety department and furnishes goggles to shop workers, and yet, in 1918, 4.6 per cent. of the injuries reported on the eastern lines were eye injuries. Almost invariably these accidents occur to men who fail to wear protectors. There is need, therefore, of active interest in the subject of protection, and the employer should feel it necessary so to organize his work as to require workers to wear the proper protectors, and should not depend upon the worker to judge whether the occupation he is engaged in requires the use of protectors.

There follows discussion of the rules in respect to different occupations, and the report ends with fifteen pages of general directions in the form of operating rules for sterilization, fitting, replacement, tests, etc., elaborating the rules given in the safety code. — G. E. Partridge.

Goggles for Locomotive Enginemen. *Gustave J. Soderberg.* Safety Engin., March, 1921, 41, No. 3, 102–104. — The demand for more power through increased fire-box area makes the task of the engineer even more arduous. Therefore the nervous strain and physical exertion should be lessened whenever possible, and goggles are one means toward such an end. The objection is made that colored-glass goggles change the color of signals, especially at night. The author maintains that smoked glass goggles bring out more clearly at night the red, green and yellow lights. — M. Dent.

Safety to Life in Ship Construction. *S. Clarke Brandenstein.* Safety Engin., March, 1921, 41, No. 3, 108–110. — The author cites the hull department as being the most hazardous and outlines the hazards under the following heads: staging, in which the chief hazard is lack of standardization; deck openings; and falling objects. — M. Dent.

Safety Methods as Applied in the Loading and Unloading of Steamships. *W. E. Welch.* Safety Engin., March, 1921, 41, No. 3, 113–114. — The hazards of stevedoring parallel those of steel frame building erection. Stevedoring accidents are classed under: stowage and discharging; making up of drafts; cargo falling from drafts and being struck with drafts; when the ship's gear gives way; and coal bunkering, when the men are struck by buckets. To eliminate accidents equipment should be of the best, carefully rigged, and inspected. — M. Dent.

Safety Features of Steam Boiler Accessories. *Warren Hilleary.* Nat. Safety News, April 4, 1921, 3, No. 14, 5–6. — Though the number of persons killed by boiler explosions has been very substantially reduced since 1881, the seriousness of the steam boiler problem even today is attested by the fact that in 1919 there were 187 deaths due to this cause. In this paper the author deals with safety valves, water gauge glass, gauge cocks, high and low water alarms, pressure gauge, and blow-off. — L. A. Shaw.

Safety Features of Steam Boiler Accessories. *Warren Hilleary.* Nat. Safety News, May, 1921, 3, No. 15, 17–18. — This is the concluding section of a paper, a part of which was published in the National Safety News of April 4. The present section deals with rotary tube cleaners, concrete floors, furnace door locks, steam flow meters and oil burners.

Rotary tube cleaners, motor or turbine driven, are the only mechanical means for cleaning the interiors of tubes of water tube boilers, since with curved tubes the cleaner wears away the metal of the tube at points near the bend. Great care should be taken to give proper instruction in the use of the cleaner. The greater the amount of scale, the slower the cleaner will travel, hence there is wear at points where the cleaner becomes stationary. Steam turbine cleaners have an added danger of the steam hose bursting.

Laid on any other soil than dry sand, concrete floors are dangerous when heated to more than 212° F., and there are risks also in places where the atmospheric temperature reaches or falls below freezing.

The installation of automatic door locks will prevent a common form of accident, *i.e.*, scalding and hot fuel burns when bursting tubes or flues push open the fire or ash pit doors.

There is no reason why every boiler operating in a battery with one or more other boilers should not be equipped with a steam flow meter, which will show the fireman whether each boiler is delivering its proper amount of steam. Then, if necessary, the fire intensity can be increased or decreased immediately. There is less danger when each boiler is doing its share of the work.

All steam or air atomized oil burners are dangerous, and the equipment used in connection with them becomes dangerous through their use. Since mechanical atomization is reasonably safe, it is probable that sooner or later all atomization will be done by mechanical processes. The one possible objection is the necessity of bringing the oil to high temperature before it enters the burner, although no accidents seem to have occurred from temperatures up to 275° F. Precaution must be taken in the use of oil to see that dampers are thrown open before firing or admitting any oil to the furnace.

Burns from hot gases passing through furnace doors are too common. They are not always caused by the explosion of furnace gas for if the damper is suddenly closed hot gases and the flames themselves will be likely to come out. A manually operated damper should be weighted so as to be held open. It is a bad practice to stand in front of a furnace door and throw in wet coal or unabsorbed water.

Guessing the time to open the stop valve from a boiler to a header which is being supplied from other boilers sometimes leads to explosion. A non-return valve should be used, in order to prevent the boiler from being cut into the line too soon. — G. E. Partridge.

A Campaign against Defective and Improper Hand Tools. Nat. Safety News, April 4, 1921, 3, No. 14, 3–4. — Tools which are defective or which are improper for the purpose for which they are used are the immediate cause of many accidents in every industry, although it has been proved that fully 75 per cent. of such accidents can be reduced by a proper inspection of the tools and by the education of the workmen. The means by which such practical measures of accident prevention may be taken are herewith briefly presented. — L. A. Shaw.

## INDUSTRIAL SURGERY

Fractures Incident to Occupation. *John J. Moorhead.* Proc. Ninth Ann. Congress, Nat. Safety Council, Sept. 27, 1920–Oct. 1, 1920, 123–134. — The central idea of this paper is the treatment of fractures in relation to the prognosis of deformity or disability. The severity of the fracture is inversely dependent upon the occupation and not upon the severity of the injury. Four essentials of surgery are given: (1) diagnosis; (2) reduction or setting; (3) retention or splinting; (4) re-education or functioning. Reduction and re-education are the most important. Only when the patient is returned to the occupation from which he came may the surgeon consider his duty done. — Elinor D. Gregg.

Traumatic Surgery Problems. *John J. Moorhead.* Jour. Am. Med. Assn., June 11, 1921, 76, No. 24, 1642–1646. — The article is summarized as follows: "The basic factors in traumatic surgery relate primarily to the treatment of infected wounds, burns, fractures, and joint injuries.

"Safety first, conservation next, are the two essential considerations.

"Sterilization of wounds by mechanical or chemical means is the end in view, and after sterilization, suture should be attempted.

"Burns are, from a clinical standpoint, wounds due to heat and should be placed in the wound class, as thereby our patients will measurably profit.

"Fractures are wounds of bones, and are always associated with lesions of the contiguous parts. Splintage should be of the removable type to permit inspection, massage and motion.

"Early mobilization of joint injuries means earlier local repair, earlier return of function.

"Physiotherapy begins early and should not be looked upon as applicable only to the final stages of treatment.

"Functional return is the greatest aim in all forms of injury, and no patient should be regarded as cured until function has been restored to the maximum.

"Traumatic surgery is not trivial surgery; on the contrary, it often demands a higher grade of surgical skill and experience than the average form of general or pathologic surgery." — C. K. Drinker.

The Pathology of So-Called Sprains of the Wrist. With a Note on Skiagrams in these Conditions. *Edgar F. Cyriax* and *Stanley Melville.* N. Y. Med. Jour., April 6, 1921, 113, No. 11, 538–540. — A brief statement of the anatomical changes occurring in wrist sprains with an outline of methods for reduction. The article itself is practically a summary. — C. K. Drinker.

Three Frequent Causes of Weak and Flat Feet. *J. T. Rugh.* Abstracted as follows from Ann. Surg., April, 1921, 73, No. 4, 499, in Jour. Am. Med. Assn., May 14, 1921, 76, No. 20, 1367. — "The first of these causes mentioned by Rugh is a shortened Achilles tendon. The second condition that mechanically predisposes to a weak or flatfoot is a hypertrophy of the inner end of the scaphoid bone. The third factor found frequently, especially in cases of congenitally weak and in flat feet, is a supernumerary tarsal bone placed at the inner side of the scaphoid and over which runs the tendon of the tibialis postiens. This bone is called the tibiale externum and by some has been called a sesamoid in the posterior tibial tendon." — C. K. Drinker.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Smoking and Mental and Motor Efficiency. *S. Froeberg.* Abstracted as follows from Jour. Exp. Psychol., 1920, Vol. 3, 334–346, in Physiol. Abstr., April, 1921, 6, No. 1, 30. — "The experiments seem to have been rather severe. The students were made to smoke 5 cent cigars; their previous experience is not mentioned, but as the author says many smoked vigorously for fear the cigar would go out, it looks as if they were not accustomed to tobacco. They were then, after half an hour's smoking, tested over a range of motor and mental functions. Steadiness in the former usually decreased; this coincides with the belief among marksmen. The mental tests showed no marked departure from the normal; some

students were unaffected, some a little better, some a little worse." — McKeen Cattell.

THE EFFECTS OF ALCOHOL AND SOME OTHER DRUGS DURING NORMAL AND FATIGUED CONDITIONS. Med. Research Council, Special Report Series No. 56, London, 1920, pp. 34. — The introduction to this report, quoted below, is a very good summary of the results accomplished by this investigation.

"The present report is the third of a series of memoirs published by the Medical Research Council at the request of the Central Control Board (liquor traffic). The earlier of the experiments now described were part of an investigation independently undertaken before the beginning of the war, but the later ones were devised to answer problems suggested to the authors by the chairman of the Board.

"In some respects the value of the experiments is enhanced, in other respects it is restricted by their at once extensive and limited character. They are extensive in so far as they deal with certain mental effects not only of alcohol, but of opium, strychnine, tea, chloroform, etc. But any loss of intensiveness arising from experiments over so wide a pharmacological field receives compensation from the similar and opposite actions revealed by their comparison. These drugs appear to fall into two antagonistic groups, (1) alcohol and chloroform, and (2) strychnine, opium, and tea, in regard to the tests applied.

"On the other hand, these experiments are limited in scope since they were carried out by only two subjects, the greater number indeed being performed on only one subject, who had never to her knowledge previously taken alcohol in any form. But though caution must be exercised in generalizing from conclusions thus based, they acquire more than ordinary value inasmuch as they issue from two experts well trained to avoid the inevitable pitfalls of human experiment. Thus they have followed Dr. Rivers's example of disguising the drugs taken and of employing control mixtures, indistinguishable from the disguised drugs and taken on the days when the latter were not taken, so that suggestion arising from foreknowledge could play no part in obscuring the true effect of the drug.

"The writers' researches on the mental effects of alcohol will naturally receive principal attention. They find that, despite the subjective feelings of greater ease in carrying out the tests, alcohol produces in them a distinct loss of precision in the dotting test, a well-marked loss of power of recall in the memory tests, and a striking reduction in the rate of alternation of phases in the 'windmill' illusion. The last named, indeed, is claimed as a very delicate index of drug effects, the writers ascribing the reduced rate of phase alternations to a rise in the resistance offered by the synapses of the neurons to the passage of the nervous impulse. Opium acts in a directly opposite manner. It accelerates the rate of phase alternations in the 'windmill' illusion, while it diminishes the errors in the dotting and in the memory tests, the attention being more easily directed to the task and to the meaning of the words learnt, and the process of recall being likewise facilitated.

"Applying the dotting and other tests to ascertain the influence of food taken with alcohol, the writers find little subjective or objective effects when alcohol, to an amount of 30 c.c., is taken with a meal, whereas when it is taken from two to five hours after a meal the effects are unquestionable in the tests employed. Applying the dotting test to determine the effects of the degree of dilution of alcohol, they conclude that the weaker the solution the less marked are its effects. Both these results are in agreement with those of Dr. Mellanby (Report No. 31 of this series) and of Dr. Vernon (Report No. 34), but they call for further research.

"A more extended investigation is also necessary in the light of the authors' interesting discovery that in the course of the protracted fatigue effects following several nights' loss of sleep, alcohol acts deleteriously during the stages of increasing inefficiency, whereas it acts beneficially as the subject later begins to regain his previous efficiency. At the former stage it increases the errors, at the latter it reduces the errors made in the tests. This suggests that an important cause of the conflicting results of past workers may be due to the stage or degree of fatigue when alcohol was taken." — C. K. Drinker.

ALCOHOL AND PRECISION IN WORK. *U. Jottermann.* Abstracted as follows from Skand. Arch. f. Physiol., 1920, Vol. 40, 107–116, in Physiol. Abstr., April, 1921, 6, No. 1, 80. — "The index of skill was the number of needles which could be threaded with cotton in 20 minutes. The subject (the author) had abstained from alcohol for 6 months beforehand.

During a preliminary period of 14 days without alcohol the daily score of needles rose to a steady maximum. He then began to take 25 c.c. of pure alcohol, diluted to 100 c.c. with water, daily at 11 P.M., the experiments being made daily at about 10 A.M. During the first few days of alcohol the score rose slightly, then fell off distinctly. It rose again during a second period without alcohol, and fell again during a second period with it. He concludes that, apart from its immediate effect, which was excluded by the interval between drinking and threading, a daily small ration of alcohol diminishes his efficiency in skilled work. The experiments are few, and the subject admits that he may be abnormally susceptible." — McKeen Cattell.

THE RELATION OF POSTURE TO INDIVIDUAL HEALTH. *Edith Hilles.* Nation's Health, May, 1921, 3, No. 5, 290–293. — The fundamental need in industry is to prevent the worker from reaching a condition of over-fatigue. It is now recognized that posture in industry is one of the conspicuous factors in fatigue. The correct postures for both sitting and standing are herein described. Emphasis is laid upon the facts that posture should be varied; that work conditions should be such that correct posture is possible; and that rest periods should be interposed where a break in the work is most needed. — L. A. Shaw.

THE THERAPY OF FATIGUE. *L. Preti.* Il Lavoro, Jan. 31, 1921, 11, No. 6, 262–268. — The objects of fatigue therapy are to preserve strength and to renew it. The author divides the different sorts of therapy into: (1) cure by rest; (2) medicinal therapy — the momentary help given by alcohol, coffee, and tea; (3) physical therapy—water, electricity, light, and air; (4) hydrotherapy — hot and cold baths and douches; (5) phototherapy which uses light as its agent; (6) aerotherapy — but do not use cold air; (7) electrotherapy; and (8) alimentary — one of the best methods to combat fatigue. — M. Dent.

SOME OF THE PREVENTABLE CAUSES OF FATIGUE. A COMMON SENSE SUMMING UP. Secretary, Committee on Industrial Fatigue. Reprinted from Indust. Canada, Dec., 1920, pp. 3. — This paper takes up briefly the effects, meaning, and causes of fatigue. The chief cause of fatigue is ascribed to the maladaptation of the worker to his job. Other causes due to working conditions are outlined under the following heads: (1) hours of work; (2) environment; (3) physical and nervous strain (speed, rhythm, rest periods, noise and vibration, monotony, and accident and health hazards); (4) general health maintenance (food, sanitary facilities, transportation, suitable clothing); (5) psychology (maladaptation of a worker to his job, inexperience, personnel, erratic management); (6) wages. — M. Dent.

FATIGUE AND EFFICIENCY IN THE IRON AND STEEL INDUSTRY. *H. M. Vernon.* Indust. Fatigue Research Board, Report No. 5. H. M. Stationery Office, London, 1920, pp. 99. — This is an important and laborious investigation of the conditions of production of pig iron and steel in England, and of the conditions in steel rolling, together with a supplementary study of the health of the workers. The processes employed and the types of machinery are described, and the paper contains thirty-nine tables besides charts and photographs of machinery.

In the manufacture of pig iron, the hand-charging of the furnace was found to be a very laborious operation, and of 146 blast furnaces inspected only 18 per cent. were mechanically charged. The rate of charging was 16 per cent. less in summer than in winter, and the rate of charging on long shifts was 8 to 15 per cent. less than on eight-hour shifts. Reduction in the hours of work of blast furnace men from twelve to eight per shift will cause very little increase of output, but data are adduced which show that the time-keeping will be improved. No signs of fatigue could be found in men engaged in charging furnaces mechanically, although they worked on twelve-hour shifts.

In steel production some heavy work is done by the steel melters, the work of "fettling" or mending the furnace floor being very exhausting. The time occupied in this process varied so widely in different plants that the author thinks there is need of an extended investigation of the system in order to reduce the laboriousness of this work. In the hand-charging of furnaces in steel production, reduction of hours from twelve to eight per shift increased the output 9 per cent. at one plant, and 2 per cent. at another, but the substitution of hot metal for cold metal caused an increase of 30 per cent. The output usually showed a seasonal variation, and at one works it was 11 per cent. less in the sum-

mer than in the winter. There was found also an intermittency in the work on some days, which increased the fatigue of steel melters. The Bessemer process does not necessitate any very heavy work. The crucible steel process does, however, but not so much as the production of wrought iron by the puddling process.

In the steel rolling processes the same seasonal variation was found as in the other operations. At two works the output was from 9 to 13 per cent. less in the summer than in the winter. Reduction in hours from twelve to eight per shift did not lead to any increase of output, but at one works, where delays were investigated and thereby reduced, output rose 16 per cent.

A classification of workers according to the fatigue caused by their work is offered, including five classes with subdivisions. The most difficult work of all is done by the open-hearth steel melters when fettling; then follows the work of puddling. Melters of hand-charged open hearth furnaces, tin-plate mill men, and crucible steel pullers-out also have very heavy work.

Sickness records of about 20,000 steel workers for six years were tabulated. The average of lost time for all causes was 6.5 days per year. The steel melters and pitmen lost 23 per cent. more than the average, the puddlers 20 per cent. more, the tin-plate mill men 12 per cent. more and the rolling mill men 8 per cent. more. Almost all of these men frequently work at high temperatures. Men who usually work at ordinary temperatures and on less heavy work showed 8 or 9 per cent. less than the average. The excess of sickness in the puddlers was due to rheumatism and respiratory diseases, caused, the writer thinks, by the custom of alternating heavy work with periods of rest or light work; the tin-plate mill men, who work almost continuously, showed no excess of sickness from these causes. During war-time (1915–1918) the men showed 31 per cent. less sickness than in the period before the war (1913–1914). Steel workers aged 25 to 65 years showed a 5 per cent. lower death rate than all males (occupied and retired). The steel melters had a 20 per cent. greater mortality than all males. The blast furnace men had a higher mortality than the steel workers.

There was found a "curious lack of provision for the comfort of the men on the part of some of the employers." In most of the iron works the blast furnace barrow-men work night and day in the open without any shelter whatever, although there is no inherent difficulty in providing protection. In many of the steel smelting shops there were no proper seats provided for the men, although they are resting half the time when on duty. The men, also, were very negligent in matters of health, especially as regards exposure after work in high temperatures. — G. E. Partridge.

Fatigue Charts. *H. Dausset* and *Boigey*. Abstracted as follows from Paris médical, April 16, 1921, 11, No. 16, 313, in Jour. Am. Med. Assn., May 28, 1921, 76, No. 22, 1538. — "Dausset and Boigey comment on the aid afforded in physical training by keeping charts showing the onset and effect of fatigue. They describe with illustrations their method for this." — C. K. Drinker.

Spells of Rest and Physical Efficiency. *P. M. Dawson* and *L. A. Wallrich*. Abstracted as follows from Am. Jour. Physiol., 1921, Vol. 55, 314, in Physiol. Abstr., June, 1921, 6, No. 3, 169. — "Bicycling with heavy weights becomes more efficient with spells of rest. With light weights, continuous riding produced better effects. With training (1 subject) the advantage of rest spells passed off." — McKeen Cattell.

Energy Expenditure in Household Tasks. *C. F. Langworthy* and *H. G. Barott*. Abstracted as follows from Am. Jour. Physiol., 1920, Vol. 52, pp. 400–408, in Physiol. Abstr., Sept. and Oct., 1920, 5, Nos. 6 and 7, 310. — "Data are given on energy elimination in a young woman performing various tasks, the figures naturally rising with increase of work; thus knitting and the like gave an average of 9 calories in excess of the sitting quietly metabolism; for dish-washing and ironing the figure rose to 24 to 40, the energy rising with the height of the table. Obviously harder work (*e. g.*, scrubbing floors) gave an increase of 50." — McKeen Cattell.

The Physiological Cost of Collier's Work. *A. D. Waller* and *G. De Decker*. Abstracted as follows from Proc. Physiol. Soc., 1920, Jour. Physiol., 1921, 112–114, in Physiol. Abstr., June, 1921, 6, No. 3, 204. — "Observations were made hourly upon 2 colliers during the morning shift on 3 successive days. The procedure was to collect expired air for 30 seconds each hour from each of the 2 col-

liers at the coal face, with least possible interruption of the work, which consisted of 'getting coal' and loading it. The volume of expired air and $CO_2$ percentage were measured at once. As the wage depended upon the tonnage got, the work was maximal (4.5, 4.0, 3.5 tons for 3 days). The pulse was taken during the collection of expired air. Curves are given which show a parallelism in the rising and falling ordinates which represent $CO_2$ discharge and pulse frequency. The physiological cost of walking 60 paces horizontally before 7 A.M. and after 2 P.M. was found to be doubled after the 7 hours of work." — McKeen Cattell.

## HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

Lessons Learned from Forty Electrical Fatalities. *S. E. Whiting.* Nat. Safety News, March 28, 1921, 3, No. 13, 3–5, 12–13. — The writer extracts the practical lessons to be learned from a study of the causes and conditions of the fatal accidents from electrical shock that have come under his notice. He emphasizes the danger and uncertainty of the low voltage circuit (from 100 to 600 volts). One case is reported of a fatal accident when the voltage was only 110. The low voltage hazard is greatest in damp or otherwise grounded locations, but several dangerous conditions can arise from the ordinary low voltage circuit. There are several precautions to be taken, such as the substitution of modern enclosed or "dead front" switches for all open knife switches; keeping all open wiring out of reach (preferably enclosing all wiring in conduits), using porcelain or weather-proof lamp sockets which should be keyless and controlled from proper wall switches; and avoiding the use of drop cords. All dead-metal parts of low tension equipment (with certain exceptions) should be permanently grounded, since there have been more low voltage fatalities from the omission to ground dead-metal parts than from any other single cause.

The high voltage circuits (from 2,000 volts up to 100,000) are considered separately. Exposure to these high tension circuits is relatively small and localized, and normally all men exposed to these high tension hazards are specially trained in electrical work. But there are some extraordinarily careless practices. Enclosing guards are often omitted, although all current-carrying parts should be covered by means of fire-proof doors or metal screens to a height of 6 or 7 feet. Careless cleaning of high tension parts is responsible for some fatal accidents, and the only safe way is to make all high tension cleaning a special job when the parts are all open-circuited and grounded before cleaning begins, and where close supervision is given to every detail of the work.

Directions are given for proper protective grounding of circuit parts and for the construction of grounding devices. — G. E. Partridge.

Paralysis of the Radial Nerve and Trophic Disturbances following an Electrical Burn. *Jellinek.* Wien. klin. Wchnschr., 1920, 33, 873. — An electrical worker accidentally touched his elbow to a conductor carrying a 5,000 volt, 42-cycle alternating current. In spite of good conduction, a portion of the current passed through the rest of his body. Heart action and respiration were restored after a half hour of artificial respiration. The burns were dressed with boric acid, and five days later a good deal of the tissue of the right arm, some of it apparently normal, had necrotized, exposing the ulnar nerve trunk and the pulsating brachial artery. This wound healed over after several months' treatment, but the ulnar paresis, motor and sensation, still remains. — Barnett Cohen.

## HEAT, COLD AND HUMIDITY

Arterial Pressure among Workers in High Temperatures. *Tedeschi.* Abstracted from Folia medica, 1920, No. 27, in Il Lavoro, Feb. 28, 1921, 11, No. 10, 300–301. — The author reports the results of an investigation among fourteen stokers and five firemen working in high temperatures. In the experiment the temperature of the air was recorded and the individual's temperature was taken, together with his pulse and respiration, and

the maximum and minimum arterial pressure. The experiments were begun when the subject first entered the room; a count was taken one and a half hours after his entrance (during work), a half hour after stopping work, while resting near the engines, and finally after leaving the engine room. The temperature of the machine room varied from 30° C. to 44° C. The author concludes that between the limits of temperature indicated there is an increase of arterial pressure due to the exaggerated action of the heart and of the vasomotor centers. — M. Dent.

Preliminary Notes on Atmospheric Conditions in Boot and Shoe Factories. *W. D. Hambly* and *T. Bedford.* Indust. Fatigue Research Board, Report No. 11. His Majesty's Stationery Office, London, 1921, pp. 69. — The summary of the pamphlet is as follows:

"1. An atmosphere which will help to sustain physical energy should be cool rather than hot, dry rather than damp, and there should be brisk air movement. Neglect of these conditions may cause physical disability and inefficiency.

"2. The kata-thermometer is designed to measure rates of cooling which are dependent on temperatures, humidities and velocities of air currents. Rates of cooling, which are expressed in figures denoting heat lost per unit area per second, give information with regard to standards of comfort and efficiency.

"3. Cheek temperatures are a valuable guide to demands which are being made on the heat-regulating system of the body. Colour and texture of clothing have a marked effect on skin temperatures.

"4. There is some evidence to show that atmospheric conditions deteriorate from morning to evening in the workshop; also that this makes additional demands on the workers' energy.

"5. Kata-thermometer records have been taken in 35 factories, including buildings of the single and multi-storey type, which were situated in urban and rural areas in various parts of the country.

"6. Examination of summer and winter records taken at several factories suggests that systems of ventilation which are adequate in winter cannot always ensure desirable physiological conditions under adverse outdoor conditions in summer.

"7. Machinery in motion has an appreciable effect on atmospheric movement. Ventilation in gold stamping and other small rooms which are shut off from main air currents should be carefully considered.

"8. The relative positions of inlets and outlets for air should be carefully determined in order to avoid 'short circuiting' of fresh air currents.

"9. Experiments carried out in an aircraft doping room show the high rates of cooling obtained by frequent air change at high velocity, and the application of a doping room system of ventilation to boot and shoe factories is considered.

"10. A consideration of ventilation in single and multi-storey buildings indicates that the latter structures have slightly higher rates of cooling, a narrower range from winter to summer temperatures, and a greater air velocity.

"11. Deductions drawn from frequency curves dealing with atmospheric conditions in principal departments suggest:

"(*a*) That rates of cooling and temperatures were not adapted to the nature of occupations.

"(*b*) There is some indication that clicking rooms were too cold in winter and too hot in summer.

"(*c*) Air velocities in each department are greater in summer than in winter. This may be due to the opening of windows in the former season. The question of making better use of outdoor air velocities in winter, and at the same time avoiding draughts, is one of importance.

"(*d*) Summer rates of cooling in press rooms were below standards recommended.

"(*e*) In lasting and finishing rooms, where heavy manual work was in progress, rates of cooling and temperatures for both summer and winter were unsatisfactory compared with recommended standards.

"(*f*) Shoe rooms were found to be too cold in winter, and in summer these departments, where sedentary work was carried on, were found to have higher rates of cooling than those experienced by heavy manual workers in lasting and finishing rooms." — C. K. Drinker.

## WOMEN AND CHILDREN IN INDUSTRY

Health Problems of Women in Industry. *Mary Anderson.* Nation's Health, May, 1921, 3, No. 5, 304–307. — Although the state has the power to make regulations affecting women in industry, no two states have adopted the same standards. A program incorporating the fundamental standards necessary to insure health has been formulated by the Women's Bureau, United States Department of Labor, and is herein outlined. The effect of repetitive processes, posture at work, lifting of weights, and of certain gases and fumes upon the health of women industrially employed is briefly discussed. — L. A. Shaw.

Women Street Car Conductors and Ticket Agents. U. S. Dept. Labor, Women's Bur., Bull. No. 11, 1921, pp. 90. — This is an investigation, in part statistical, of the employment and conditions of work of women on the street railway systems in several large cities of the United States. The conclusion is reached that, when conditions are made favorable, there are very few branches of this occupation barred to women; that while the conditions must be adapted to the requirements of women workers, it is always possible that too stringent regulations may curtail their opportunities for profitable employment. Protection of women from the ill effects of long hours and unsatisfactory working conditions must accompany their entrance into any new occupation, and in considering opportunities for them it is necessary to study the methods by which the needs of the industry can be reconciled with the legal regulation of hours and working conditions — an especially difficult task in view of the unusual requirements necessary for transportation work.

Studies were made in four cities: Boston, Chicago, Detroit, and Kansas City. The conclusion was reached, after the investigation in Detroit and Kansas City, that, although conditions were not ideal, there was nothing to show that the work of a street car conductor was unfit for women. "The Detroit women worked longer hours at night, and frequently seven days a week, but their pay was good and each woman who was interviewed found the work congenial, not too taxing physically, and better paid than any work she had ever done before." As regards the ticket agents in these two cities, the records show "that with a wage far superior to that paid women in many other occupations, the woman ticket agent and collector is an accepted and permanent fact in two large cities."

The second part of the report contains the statistical data collected in the four cities mentioned. Age, marital condition and number of dependents, hours of work and their division, wages, etc., are shown in tabular form, and there are summaries of the reasons given by the employees for liking their occupation, and of their opinions regarding legislation concerning it. — G. E. Partridge.

New British Legislation Affecting Women and Young Persons. Internat. Labour Rev., Jan. 1, 1921, 1, No. 1, 121–126. — Two acts have been passed by Parliament in order to embody in law certain provisions of the Draft Conventions and Recommendations adopted by the Washington and Genoa Conferences. The first of the acts brings the British law into conformity with the Washington Conventions concerning the minimum age for the admission of children to industry and the night work of women and young persons. It fixes the minimum age for the admission of children to employment at sea in conformity with the Genoa convention.

An amendment was moved which authorized the Secretary of State to issue orders allowing the employment of women and young persons over 16 years in two shifts under certain conditions, but an additional proviso was made that an industry as a whole should have the power to veto an order of the Home Secretary applying to any particular firm in that industry. This gives joint representative bodies of employers and workers in any industry (which in some cases will be the Whitley Councils) statutory power to govern their own affairs regardless of the wishes of the government, which is a remarkable innovation in British factory legislation.

The remaining provisions of the act merely bring into operation certain provisions of the Washington Conventions which differed from existing provisions of the British law.

The act for the better protection of women and young persons against lead poisoning provides a new system in British legislation

for the protection of workers in unhealthy industries. The new act imposes a set of general provisions to be observed in all places where women or young persons under 18 years are employed in any process involving the use of lead compounds. The act follows closely the recommendation of the Washington Conference in regard to the processes from which women and young persons are to be excluded, and provides that lead dust or fumes shall be drawn off as nearly as possible at the point of origin; that the persons concerned shall submit to regular examinations; that no food or drink or tobacco shall be brought into a workroom where a lead process is carried on; that adequate and clean protective clothing shall be provided by the employer and worn by the worker; that suitable cloak-rooms, mess-rooms, and lavatories shall be provided; and that workrooms, tools and apparatus shall be kept clean. There are other provisions in regard to power of inspection and the suspension from work in a lead process, if continuance therein would involve special danger to health. — G. E. Partridge.

Trend of Child Labor in the United States, 1913 to 1920. *Nettie P. McGill.* U. S. Dept. Labor, Month. Labor Rev., April, 1921, 12, No. 4, 717-730. — "Within the last few months persistent newspaper statements to the effect that children were continuing, despite a gradual return of the country to peace-time conditions, to go to work in increasing numbers, caused the United States Children's Bureau to bring up to date statistics bearing on numbers of children entering gainful employment which it had secured as a result of an earlier inquiry."

The writer comments on the difficulty of securing reliable figures for analysis. "Only a few states regularly compile statistics of employed children and these cover only manufacturing and, in some instances, mercantile pursuits and are so various as not to be comparable." Twenty-nine representative cities are selected for study of the trend of child labor during the period 1913–1920, and illustrative tables are given. The subject is discussed under the following divisions: child labor before the war; effect of the European war on child labor; child labor after the United States entered the war; children illegally employed; post-armistice conditions; and child labor in 1920. — R. B. Crain.

Health Needs of Working Children. Am. Child, Feb., 1921, 2, No. 4, 288–291. — This paper reports an informal conference for the eastern states on the health needs of the boy and girl in industry, which was held under the auspices of the United States Public Health Service and the American Social Hygiene Association. By the "boy and girl in industry" is meant all young people under 25 years of age who have left school and are engaged in gainful employment. The conference was largely directed at the problem of venereal disease.

The interest of the employer in all health matters is one of economy as well as humanity. The human waste in industry is enormous and must be reduced if industry is to progress. Health measures should originate within the industry so that employer and employee may progress with mutual benefit. The trade unions are co-operating with the United States Public Health Service in educational activities.

The really significant consideration of such discussions is the recognition of this unexplored field of the public health movement — namely, the health needs of the boy and girl in industry. This meeting to consider the prevention of venereal disease in industries is an index of a larger problem in regard to this group of workers. Our health services must bring about: (1) protection from the hazards of industry and unhygienic living; (2) provision of proper health service and health education. — Elinor D. Gregg.

Child Labor and Mental Hygiene. *R. G. Fuller.* Survey, March 19, 1921, 45, No. 25, 891-892. — So far the physical effects of child labor have been given more consideration than the mental effects; and yet the psychical effects are quite as numerous and quite as menacing to future happiness and efficiency as the physical. The nervous disorders and derangements, to which child labor may be a contributing cause, are of great variety, and include such diseases as chorea, dementia praecox, hysteria and neurasthenia.

Child labor in many of its forms constitutes a repressive environment, which inhibits the functioning of the natural impulses. Work performed thus, with defective motivation and in opposition to native tendencies, leads to nervous disturbance directly, through environment, and indirectly, through fatigue. The first effect is emotional. An inner disturbance

is set in motion, which takes the form of separation of thought from action.

The excessive child labor turnover is significant from the standpoint of mental hygiene. In part it is due to adolescent restlessness, but in part it is caused by the failure of the work to satisfy normal instincts. The child is vainly seeking self-expression, and so goes from one place to another without acquiring any sound training. — G. E. Partridge.

Child Labor in Imperial Valley. Am. Child, Feb., 1921, 2, No. 4, 291–294. — This paper details the publicity given to the report of Miss Emma Duke on child labor in California. In general, the press comments were intelligent. There were, however, a few exceptions in which the report was badly garbled and misquoted.

It is difficult to overcome the idyllic conception that children never work in the country. The story of child labor in agriculture will have to be told many times before the weight of public opinion against it is felt enough to oblige the employers to change. The editorial published in one of the newspapers of the Imperial Valley not only misquotes the report and denies the statements of officials of the state as to school attendance and child labor, but also asks its readers to deduct the children of Mexican contract labor from these reports. Why deduct the Mexican children? Hope is expressed for state funds to enforce the present child labor laws and the Board of Education is arranging for migratory teachers to follow these families as they move to new fields of labor. — Elinor D. Gregg.

Night Employment of Young Persons. *W. K. Beard.* Ann. Rep. Chief Inspect. Factories and Workshops for the Year 1919, London, 1920, pp. 95–103. — Night employment of young persons is allowed in some industries, and this report summarizes the results of a survey of the present extent and conditions of this employment. It contains data about blast furnaces, iron mills, reverberatory and regenerative furnaces, paper mills, letterpress printing, galvanizing sheet metal and wire, electrical stations, china clay works, glass works, and printing and newspapers. The report shows upon what processes in these industries young persons are engaged, and what conditions make such employment necessary. The necessity for night work is found to arise in general in connection with continuous processes and other processes closely related to them. It is evident that some of this work is unsuitable for the young, and although some abuses, such as the employment of boys on long shifts, as in blast furnace work where sixteen-hour shifts are sometimes required, have been abolished, there still persists a condition that is being improved only slowly and then mainly by changes in machinery or in the processes used. Improvements such as the introduction of gas-firing of furnaces are both economic and favorable to the elimination of unsuitable night work, but in some industries no such changes can readily be made. In some cases, the introduction of electrical driving for auxiliary machinery has increased the number of boys employed, since the operation of the controls has been simplified; while in other cases centralization of switches has reduced the number of boys engaged in these processes.

In the paper mills, the work is lighter than in some of the iron industries, and the present conditions are favorable for the training of many boys to become skilled workmen. In newspaper work, increase in the number of linotypes and monotypes, substitution of rotary for flat-bed machines, smaller and fewer papers, trade restrictions and the high cost of overtime have caused a decrease in the amount of night work.

Glass works take advantage of the special exception which allows them to employ boys of 14 years and upwards, and still carry on night work very generally. Many boys are employed, but only a small proportion will ever have the opportunity to become expert glass workers. Present conditions require continuity in the work, and there is a tendency rather to increase than to decrease the number of young persons employed in the industry, although, in the opinion of the writer, boys could be dispensed with in some parts of the work in which they are now employed. — G. E. Partridge.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Painting Profits into your Factory. Factory, March 1, 1921, 26, No. 5, 595–596. — Paint adds materially to the better operation of the industrial plant. The illuminating engineer, the plant oculist, the painter and the power-plant engineer can all work together to the same end. White paint extends the lighting area of every light source, and by throwing light upon the machine it makes faster work possible. The width of a mill building is limited by the distance to which light from the side windows can penetrate; therefore white paint adds to the possible width of the structure. Of all colors, white reflects the greatest percentage of light striking at any angle and from all sources, the coefficient of reflection being from 67 to 68 per cent., while light tints of blue and green have a coefficient of only 54 to 55 per cent., and dark shades of red and green only 11 to 12 per cent. The rays from powerful lights falling upon dark walls give much less light than the rays from less strong lights falling upon walls painted in light colors. There are now available dust-resisting washable paints, and paints adapted for use in locker rooms, first-aid rooms and hospitals which can be cleaned with disinfectants and are an aid in the prevention of disease. — G. E. Partridge.

Eliminating Vibration, an Enemy of Production. *Charles L. Hubbard.* Factory, May 1, 1921, 26, No. 9, 1075–1078. — Constant noise is fatiguing, and fatigue lowers production and causes accidents. Although noise cannot be eliminated entirely from the processes of manufacturing, there are avoidable noises and vibrations that can be overcome; for example, excessive vibration of buildings from machines having heavy reciprocating parts, such as steam engines, pumps, air compressors, and refrigerating machinery; noise and vibration from electric motors and ventilating fans; steam pipe vibrations; shrieking and flapping of belts; grinding of heavy metal gears; noise from valves with dry stems and loose packing; roar of air in ventilating ducts; water hammer in pipes; explosive exhaust from gas and steam engines; the hum of transformer stations; and many other noises.

Primary or air vibration from high-speed motors, etc., may be overcome in cases where the motors are isolated or scattered, by providing a wooden box or housing lined with heavy asbestos paper. The ventilating spaces necessary at the top and bottom of this box, however, allow the noise to be transmitted and should be avoided in the case of large units by making a connection with the ventilating system. In some instances it is necessary to consider rooms as units and give attention to construction to minimize the sound, etc. Foundation vibrations are corrected by two methods: (1) anchoring the machine to a foundation too massive to be set in motion; and (2) insulating the machine by some elastic material. Various methods of foundation insulation are described, and diagrams are shown. For insulating material cork, either granulated and pressed into blocks with suitable binding material, or cut in strips from the natural bark, is probably the most satisfactory. Machines may be insulated separately, or in groups; sometimes a number of units are best handled by separating the part of the floor that supports them from the rest of the building. Such separation may be accomplished by insulating a number of floor beams, and this may be done in most cases by placing layers of natural cork beneath the bearing surfaces of the girders. If the floor area is large, it may be supported upon independent ground foundations.

Mountings of ventilating fans in the upper parts of buildings may be anchored to heavy brick cross walls, or a platform may be constructed on light girders, one end embedded in a side wall, and the other supported from overhead. Noises or vibrations from fans are often corrected by making a flexible connection between the fan outlet and the main duct by means of a short canvas sleeve. The grinding noises of metal gearing may be reduced by the use of wooden teeth in one of the members for the larger sizes, and rawhide for the smaller. Sometimes silent chain drives can be substituted.

Noises from steam pulsation and water hammer are small in magnitude but the vibration is readily transmitted to the building. The practical way of dealing with steam pulsation is to install a receiving or equalizing chamber in the steam main near the engines. When there are two or more engines exhausting into the same main, the branches should enter at

an angle, and the horizontal portion of the main should be increased over the combined areas of the branches. Water hammer in connection with a pump may generally be eliminated by attaching air chambers and vacuum chambers, and in overhead and dry return pipes the remedy is to reduce the area of contact of steam and water to a minimum, and to prevent their coming together at slightly different temperatures. — G. E. Partridge.

Five Tests for Good Lighting. *F. C. Norman.* Factory, Feb. 1, 1921, 26, No. 3, 344. — The following five tests for good lighting are given:

"1. The light must furnish the user with sufficient light so that he can see to work.

"2. The light must be so placed that it does not cause the pupil of the user's eye to change in size when he is using the light under normal conditions.

"3. The light must be steady.

"4. There shall not be any polished surfaces that will reflect light from bright spots within the worker's line of vision.

"5. The light must not shine in the eyes of some other worker." — M. C. Shorley.

Solving Lighting Difficulties. *N. O. Vorch.* Factory, Feb. 1, 1921, 26, No. 3, 344. — This paper has to do with the difficulties caused by gas lighting. In one factory where incandescent burners could not be used because of the risk of mantles breaking owing to the constant vibration, inverted gas burners, each of 75 candle-power, with anti-vibrating springs and suitable shades, were fitted over benches for local lighting, and a series of lamps of 400 candle-power each were fitted down the center of workrooms for general illumination. Special high-pressure gas burners were used and a scheme was devised to prevent rapid clogging of burners by arranging for all air passing through the burners to be drawn from the outside. — M. C. Shorley.

Ventilation. *C. C. Sherlock.* Abstracted as follows from Am. Machinist, March 3, 1921, in Factory, May 1, 1921, 26, No. 9, 1134, 1136. — "The employer's common law liability is predicated upon negligence, and unless this negligence is present, he cannot be held to pay for the injuries sustained. . . . The basis of liability under the compensation act is not upon negligence, but upon the fact that injury has occurred as a result of an accident arising out of, and in the course of the employment. . . . If the employment increases the normal hazard, accidents as a result of the increased hazard are accidents within the meaning of the compensation acts. . . . Specific provisions in the safety appliance acts, the factory acts or the industrial codes relating to ventilation must be strictly complied with without reference to the workmen's compensation acts. The mere fact that the employer is to pay compensation in case injury occurs is not sufficient reason for holding that the compensation acts abrogate the safety appliance acts or other acts which seek to prevent injuries. . . . There is liability, under both the common law and the specific acts, for insufficient ventilation in the place of work, and it is this sort of liability that is best met in a preventive fashion. It pays to prevent when there is a possibility of legal liability attaching." — G. E. Partridge.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Health Service in Industry. Nat. Indust. Conference Board, Research Rep. No. 34, Jan., 1921, pp. 61. — This report is a discussion of the progress of health work in industry based upon findings obtained through visits made in 1921 to ninety New England industrial establishments and upon other studies of the National Industrial Conference Board, and presents the following: (1) a review of the functions of the physician in industry; (2) an analysis of the extent and character of health supervision in New England industries; (3) staff organization; (4) equipment; (5) first-aid work; (6) physical examinations; and (7) use of medical records.

The development of industrial medical service is traced from the time when the plant physician conducted his work much as a private practice to the present time when the able industrial physician is concerned intimately with the multiplicity of factors which are related to the health of operatives and ex-

ecutives, when he is equipped with detailed knowledge of industrial health hazards and of the many intricate processes which are involved in modern manufacturing. The report states that "the plant physician, more than any other member of the industrial organization, is in a position to project himself without evoking resentment into the home and community life of workers and to assist in the proper adjustment of disturbing factors in these fields." There are suggested broad opportunities which lie in the scope of industrial medicine for investigative and administrative work regarding preventive medicine and hygiene.

The ninety industrial plants of New England which were visited for purposes of this study employed 317,000 workers. These plants employed 37 full-time physicians, with 63 part-time physicians, and 23 physicians on call. There were 1 full-time and 1 part-time oculist, 7 full-time and 6 part-time dentists, 22 male nurses, 155 female nurses, 27 visiting nurses, 34 first-aid attendants, and 43 clerks. Twenty-five of the establishments required physical examination, though in not all instances was this examination detailed. In forty-four plants the medical department was responsible to the director of personnel, employment manager or other subordinate official in the administration. In four plants the physician was in charge of the service department, including the medical work. In thirty-nine instances the plant physician was directly responsible to the organization executive. Special note was made of the lack of adequate records in many of the plants. In but few establishments were valuable records found.

In the discussion upon staff organization it is pointed out that the size of the medical staff is determined by the nature of the industrial processes rather than by the number of workers, and it also varies with the character of the medical work to be done. Investigations show that there are industrial establishments employing as few as 300 workers which have a full-time trained nurse and a physician on call. Certain establishments with 500 or more workers employ part-time physicians, some a full-time physician in addition to a trained nurse, and other plants with 1,000 or more workers employ a full-time physician and one or more nurses. The statement is made that in very large plants one full-time physician for every 2,000 employees, together with the necessary nursing and clerical personnel, has been found satisfactory. The importance of industrial dispensary service for groups of small establishments is emphasized.

The section on equipment presents the standards of the Conference Board of Physicians in Industry and recognizes the first-aid equipment suggested by this Board. It is probable that this equipment, devised some years ago, could now be much improved upon. In the section upon first-aid work the standard first-aid methods advanced by the Conference Board of Physicians in Industry for application to various types of injury are set forth.

Physical examinations, the report indicates, are particularly valuable for the detection of defects and limitations of labor applicants, and where such examinations are properly employed a handicapped worker may be assigned to a job suitable for him. There is emphasized the opportunity which is thus brought about for the institution of corrective measures and for the education of the worker regarding his health. It is stated that on an average from 3 to 5 per cent. of all applicants examined have been refused employment because of physical defects. Together with a standardized method of physical examination adopted by the Conference Board of Physicians in Industry there is printed a standard record form recommended by the Board. It is doubtful if the record form is in accordance with the best modern practice and it might well be revised. The average time required in thirty-three plants for the making of the routine examination was eleven minutes per person. Eliminating the plants in which the examination was thoroughly made the time required was eight minutes. In many of the larger plants a satisfactory examination was given in from four to six minutes. There may be some scepticism regarding the satisfactoriness of a four minute observation of a labor applicant, particularly if it is hoped through physical examinations to establish a basis for a constructive health program.

It is of interest that the restriction of employment of defective workers is based upon the possibility of danger to themselves, to others, or to property, and that applicants with a great variety of abnormalities are accepted for employment. Many plants accepted men with hernia, with flat feet and with varicosities. Fourteen plants reported re-examinations were conducted regularly at intervals varying from one month to three years, while a number

of other plants conducted re-examinations upon request and upon interdepartmental transfer of workers.

The last section of the report dealing with the use of medical records presents standards of the Conference Board of Physicians in Industry regarding limitations of four classes of physical fitness in relation to employment. With this there is offered a list of examination standards in reference to physical defects necessitating special attention. The report ends with a plea for the development of comprehensive information regarding industrial morbidity and injuries, and presents in tabular form the minimum data which should be recorded in this study of industrial absenteeism. — Wade Wright.

Cost of Health Service in Industry. Nat. Indust. Conference Board, Research Rep. No. 37, May, 1921, pp. 33. — The value of this report hinges upon the question as to whether we can generalize upon the matters involved in it. It will be widely quoted and it gives a useful summary of the amount of money devoted by a number of industries to an item of expense which they call health service. In our opinion data as to the cost of "health service" with no direct critical examination of what the service in individual cases may be is of little value.

In two previous investigations in 1915 and 1916 the cost of health service averaged \$1.88 and \$2.50, respectively, per year. "The information summarized in this report (No. 37) was gathered largely by means of questionnaires submitted to manufacturing plants in representative industrial communities throughout the country. . . . In the plants reporting, a total of 764,827 workers were employed, of whom 631,582 were males and 133,245 were females. The number of workers per plant varied from 129 to 39,960." Two hundred and seven plants located in twenty-four states make up the group studied. "Forty-nine are in the New England states, 78 in the Middle Atlantic group, 68 in the Central group, 7 in the South Atlantic region and 5 in the Western states." The conclusions reached are as follows:

"While this study shows that the cost of health service per employee has substantially doubled since the estimates of 1916 were made public, this increase has not been out of proportion to increased costs in general. The average cost, as shown by this investigation, ranges from \$1.84 per employee per year in the tobacco industry to \$24.40 in the mining industry, *averaging, for all the industries reporting, \$4.45 per employee per year.* With the increased cost of health supervision during the past four years, however, has gone a much greater increase in scope of work and service rendered. While medical service was introduced primarily to care for industrial accidents occurring within the plant, its work today, as shown by this investigation, reaches into practically all departments and into many activities of the industrial organization, and in certain cases even into the home and community life of the management and workers. Thus, when the various activities pursued and services rendered by the medical department are considered, it becomes plain that a large amount of constructive service is given at a very moderate cost."

The most substantial evidence which the report contains bearing upon the character of the medical service under study rests upon the rather insecure foundation that in the 207 plants 241 full-time physicians were employed. These full-time men served in only eighty of the establishments, and the best average ratio of physicians to number of workmen found in plants employing over 10,000 men is one physician to 2,770 workers. If we granted that the plants possessing full-time physicians were invariably rendering effective health service, we are able to collect data from Tables IX to XIV, inclusive, of the report which show that the cost of this service is \$6.38 per employee. With a variation in cost between \$40.46 per employee in one instance and \$1.21 per employee in another it is obvious that the character of the service differs enormously and any figure representing average cost is of comparatively little value. Finally, therefore, it would seem to us that the substantial and permanent entrance of medicine into industry justified a careful examination of a limited number of plants and a final estimate of cost of health service based upon the real character of the service rendered. Estimates lacking such analysis neglect the fundamental necessities of the situation. — C. K. Drinker.

# ABSTRACT OF THE LITERATURE

## OF

# INDUSTRIAL HYGIENE

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## GENERAL

INDUSTRIAL DISEASE AND IMMUNITY. *Sir Kenneth Goadby.* At a meeting held on May 30 at the Royal Society of Arts, Adelphi, an illuminating and instructive lecture was delivered by Sir Kenneth Goadby on the subject of industrial disease and immunity, derived from nine years' experience as Specialist Referee (Home Office) for industrial diseases. In the course of this address many important facts were brought to notice, and prominence was given to the hitherto little studied question of the susceptibility of workers to the various dangers peculiar to their employment. The lecturer classified industrial disease into primary or intrinsic, due to the handling of specific deleterious material, and secondary or extrinsic, in which the nature of the occupation excites a predisposition to general diseases, such as tuberculosis and arteriosclerosis. In the former category he included those diseases caused by bacterial infection, notably anthrax, arising from the handling of infected hides and hair. This very grave disease, in spite of increased antiseptic precautions, is still prevalent, although, as was shown by a chart, the mortality from it has been considerably reduced by specific serum treatment. The problem of susceptibility to anthrax is one still unsolved and much remains to be learned as to why, among the many liable to infection, some contract the disease and others go scotfree. Possibly the answer lies in the greater or less protective and phagocytic power inherent in certain of the white cells of the circulating blood of in-

dividuals, or, as was suggested in the discussion subsequent to the lecture, in the variable resisting properties of the skin. For it is a remarkable fact that the palms of the hands, the parts most exposed to infection, invariably escape, whereas the pliant skin of the arms and neck appears to be more vulnerable and to provide a more suitable foothold for the anthrax bacillus.

Among diseases arising from actual contact with poisonous material were named poisoning from trinitrotoluene (T.N.T.) and drugs. The former only came into prominence during the war in the preparation of explosives; much harm resulted and many fatal cases of T.N.T. poisoning occurred among workers until its deleterious action was recognized and, in some measure, guarded against by adequate precautions. As with T.N.T., so with drugs, individual susceptibility varies considerably, and a striking instance of such susceptibility was quoted of an employee, who was so sensitive to the effects of belladonna that even after removal from all contact with that particular drug the wearing of the overalls, which he had used in his former work and which carried traces of the drug, was sufficient to produce a return of the belladonna rash from which he had previously suffered.

The third class of primary diseases described were those due to dust, fumes and vapors in connection with lead, arsenic, mercury, paint and dope. Much important information was forthcoming on the subject of white lead and leadless paint, and the readiness with which complaints were attributed to lead poisoning was criticized as exaggerated and inaccurate. Comparisons of the amount of invaliding and liability to the development of secondary disease, particularly arteriosclerosis, were made between workers in white lead and painters using leadless paint.

Tables were given showing that in both classes the tendency to arteriosclerosis, as evidenced by recorded blood pressures, increased during the first year of employment, and was less marked in the succeeding three years, by which time workers had acquired some degree of immunity to the effects of the poison; but in subsequent years up to fifteen it was evident that this immunity tended to disappear and the degree of arteriosclerosis became more pronounced. The striking feature, however, appears to be that the tendency to a higher blood pressure and consequent development of arteriosclerosis was less marked among the workers in white lead than among painters using leadless paint, and this difference was attributed to the effects of turpentine among the latter class of workers — a reversion in fact to the belief, which existed many years ago among house painters, that the harmful results of a painter's employment and the susceptibility to the influence of paint among occupants of a newly painted house were due rather to turpentine than to lead.

Charts showing the various employments in which white lead and leadless paints, respectively, are used demonstrated not only the greater liability induced by the latter to the development of high blood pressure and its harmful effects, but also the marked reduction in the amount of sickness, as the result of better precautions for the benefit of the individual worker and of general hygienic improvements in factories in recent years. Particularly was this evident in the influence of more adequate ventilation and space and greater cleanliness on the amount of tuberculosis among factory workers and among persons working with various forms of dusts. Part of this amelioration, however, must be attributed to the weeding out of the weakly and unfit from unsuitable occupations, as the result of systematic medical inspection.

Much undoubtedly remains to be done, as Sir Kenneth Goadby pointed out, to improve still further the conditions of factory work and to maintain the fitness of workers. Much, too, has yet to be learned on the subject of predisposition to occupational disease, in particular the part played by minor diseases in lowering natural immunity. Research is needed along the lines advocated and already introduced by the lecturer in reference to the importance of investigations into the blood pressure and changes in the blood itself. "The application of such tests at the preliminary and subsequent medical examinations would help in eliminating those unfitted for particular employment, and the selection of workers for specially dangerous occupations would probably reduce the incidence of industrial poisoning and possibly render safe trades at present regarded as dangerous." There is much ground for belief in the truth of the assertion made by Sir Kenneth Goadby that industrial disease is a potent factor in the causation of unemployment. For that reason alone the subject demands the serious attention not only of the government authori-

ties, but especially of the trade unions and labor organizations.

The feeling of the meeting was ably expressed by the Right Honorable J. R. Clynes, who in opening the discussion emphasized the vital importance of the subject of industrial disease. He fully endorsed the lecturer's call to trade unions to add to their work of relieving actual sickness, the safeguarding of the health of workers — a matter of more moment even than the intricacies of the wage problems. The efforts demanded of the medical profession and of factory inspectors in pursuit of such a goal are of no light character and would draw no eulogy from Parliament or Press; for sole reward there would be the sense of duty done for the sake of their fellow beings and in the cause of the health of the nation. He greatly hoped that the Whitley Councils would eventually be free to deal with this subject which, besides being a matter of great national importance, is of such mutual interest and benefit alike to employers and employees.

The subsequent speakers included Dr. T. M. Legge, who dwelt on the value of the education of the worker in matters of personal hygiene and cleanliness, particularly in relation to his employment, and claimed that the preventive side of preventive medicine was too often neglected, which accounted for the still too high prevalence of many industrial diseases.

Dr. Halford Ross described the good results attending the efforts of the industrial commission in the printer's trade, the successful measures adopted to counteract and overcome the harmful effect of fibre dust in the compositor's room, and the great hygienic advantages attaching to the use of the photographic process for printing in place of the unhealthy system of handling and setting up type.

Professor H. E. Armstrong made a protest against the amount of official inspection to which every individual is subjected and which is fast reaching a serious limit when one will no longer be allowed to work without having to submit to blood pressure tests. He considered much of the occupational disease among workers attributable to bad feeding, particularly poor quality of food, and to bad teeth. A pure milk supply for the laboring classes would, in his opinion, go far to reduce liability to disease of industrial origin. — Graham Forbes.

Industrial Hygiene. *Neville Chamberlain.* Jour. Roy. Sanitary Institute, Jan., 1921, 41, No. 3, 230–234. — A brief résumé of the progress of industrial hygiene from the fearful conditions existent in 1815, when children often worked from 3.30 A.M. to 9.30 P.M. in the summer, to the model conditions existent today in some of our best factories. The author goes on to say that, though there is matter for congratulation in improved conditions, there is none for complacency, for "industrial hygiene is still rather a collection of experiments than an organised science." He believes that future progress lies in prevention rather than in cure. M. Dent.

Industrial Health: Its Value in Public Health Service. *E. L. Collis.* Internat. Jour. Pub. Health, March April, 1921, 2, No. 2, 123–139. — During the past two hundred years, far greater changes have taken place in the life of civilized nations than occurred during the previous four thousand years, and these changes, which are so profound and comparatively sudden, must react upon the physical and mental characteristics of the race. Modern industry has brought many new influences into existence, and at the same time it has provided unique opportunities for observing the reactions that follow.

We may investigate the effects of different influences by taking the records of: (*a*) industrial birth, as reflected in labor turnover; (*b*) industrial life, indicated by time lost, output, industrial fatigue, and industrial unrest; and (*c*) mortality, the final result of the stress and strain of life. Investigation has shown that labor turnover varies widely; that the great majority of workers leave without any sufficient reason, and that only from 10 to 25 per cent. give ill health as the reason, although ill health is probably an underlying cause in a larger proportion of instances. The rate of labor turnover is highest during early weeks and months after engagement and varies with age, juveniles leaving more rapidly than adults, and the old more rapidly than younger adults. Moreover, the rate is higher for women than for men, and higher for married women than for single women. Labor turnover may be diminished in three ways: through selection of workers, through attention to conditions of work, and through close personal touch with the workers. Steps taken to minimize labor turnover react favorably on the whole of industrial life.

Influences similar to those affecting labor turnover also affect sickness, which varies with

sex, age, and length of employment, there being more sickness among new workers than among the more permanent staff. As regards fatigue, it has been found that when activity is at its best, output, beginning Monday morning, quickly reaches a height which is then slightly increased during the day, and on each succeeding day of the week begins higher than the day before, and increases during the day. A tendency for the output to fall during the afternoon of Monday is associated with a tendency for the output of Friday to fall below that of Thursday, etc. Associated with these falls of output, and proportional to them, are high labor turnover and increased lost time from sickness and accidents. When, with proper physical conditions, the output does not attain the ideal form, there is indication that rest periods ought to be introduced.

Industrial unrest is to be considered also among the physiological reactions, and inquiry into the amount and kinds of morbidity experienced by industrial groups most liable to unrest might show the way to lessen liability to that prolific form of economic loss — the strike. Studies have already shown in one instance — in connection with the general coal strike in England and Wales in 1920 — a relation between mortality rate and tendency to strike. Mortality as related to the conditions of various industries requires much more investigation.

With regard to accidents, there is some reliable information. About 80 per cent. are caused by carelessness, and they are also influenced by hours of work, by temperature and by light. They appear to depend more upon the condition of the health and upon alertness than upon other conditions, and to prevent them we must improve the general health of the workers and educate them to understand the dangers associated with their work. — G. E. Partridge.

Measures for Increasing the Supply of Competent Health Officers. *John A. Ferrell.* Jour. Am. Med. Assn., Aug. 13, 1921, 77, No. 7, 513–516. — The author's summary is as follows: "The demand for qualified health officers already exceeds the supply, and the rapid expansion of public health activities will be limited by the supply of qualified health officers to a much greater extent than by a lack of funds. Measures that have suggested themselves for increasing the supply of qualified men are:

"1. The divorce of health work from politics.

"2. Increase in the compensation of health officers.

"3. The acquainting of students, medical and academic, with the opportunities for careers in preventive medicine.

"4. Provision of advanced training in public health in a few institutions well equipped and strategically located.

"5. Teaching of public health in medical schools.

"6. Encouragement of federal and state institutes for training health workers.

"7. Education of the public to understand and value health work.

"8. Provision of scholarships and fellowships in schools of public health for present and prospective health officers." — C. K. Drinker.

The Health and Welfare of Postal Employees. An Interview with Hon. Will H. Hays, Postmaster General, Washington, D.C. Nation's Health, July 15, 1921, 3, No. 7, 387–388. — Postal buildings are under the control of the Treasury Department and any repairs or improvements needed must be obtained through that department. All of the benefits provided by private institutions for their employees are more or less hard to secure from the government. Postmaster Hays purposes: "(1) to make such rectifications as in all decency and fairness must be made to assure a square deal; (2) to strengthen and broaden the Civil Service at every point wherever possible to the end that merit may govern; and (3) with absolute fidelity to put the entire service upon a purely business basis so sound and so serviceable that no political party will ever again dare attempt to ignore or evade it ultimately." — M. Dent.

Car-Pushing in Coal Mines. *Powers Hapgood.* Survey, June 4, 1921, 46, No. 10, 310–311. — John Brophy, president of District No. 2 of the United Mine Workers, suggested a study of the conditions relating to car-pushing in coal mines, a study which has since been conducted and will soon be printed. Mine owners and operators contend that the evils are greatly exaggerated, but the soft coal miners say that car-pushing is injurious to many men and tends to shorten the working life of the miner, and that the miner is able to do the mining long after he is too old to push cars. Some say that the companies ought to haul the cars by mules, hoists or reel motors. Cases are briefly described to support the contention that the miners have a real grievance. — G. E. Partridge.

# SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

## CIRCULATORY SYSTEM

Studies on the Resistance of the Red Blood Cells. Resistance of the Red Blood Cells in Health to the Hemolytic Action of Sapotoxin. *Charles Hugh Neilson* and *Homer Wheelon*. Jour. Lab. and Clin. Med., May, 1921, 6, No. 8, 454–462. — The authors conclude as follows:

"I. A rapid method is described for the determination of the degree of resistance of the red blood cells to a specific hemolytic agent — sapotoxin. The average maximal resistance of the corpuscles in the whole blood of 99 individuals chosen as normals was a 1: 13,769 strength sapotoxin solution. Eighty-six determinations on H. W. over the course of the experiments averaged a 1: 14,130 strength solution. The average of all normal readings — 185 — was a 1: 13,937 solution. The average length of time for complete hemolysis to occur in a 1: 13,000 solution at a constant temperature — 25°C. — was 10.7 minutes. The average hemoglobin as determined by the Tallqvist hemoglobinometer was 91 per cent. for all cases. Washed corpuscles from 12 normal cases suspended in isotonic salt solution were found to show a minimal degree of hemolysis in a 1: 37,375 sapotoxin solution. Findings in luetic, pregnant, and jaundiced cases are also given. Washed corpuscles diluted 1: 1 with normal saline solution gave practically a normal count, hence mass action was ruled out because of this dilution. Also, washed corpuscles diluted 1: 1 with their own serum demonstrate practically the same resistance against sapotoxin as cells present in whole blood. The red blood cells normally show a remarkable degree of constancy in their resistance to a specific hemolytic agent.

"II. Therefore, it may be concluded that the presence of the blood fluid about the red cells acts in such a manner as to resist the hemolytic action of sapotoxin." — C. K. Drinker.

The Phagocytosis of Solid Particles. III. Carbon and Quartz. *Wallace O. Fenn*. Jour. Gen. Physiol., May 20, 1921, 3, No. 5, 575–593. — The author summarizes as follows:

"1. The rates of ingestion of quartz and carbon particles by leucocytes, when both are in suspension in serum, were compared with the availability of the two particles as predicted from the calculated chances of collision with the leucocytes, and it was shown that carbon is ingested about 4 times as readily as quartz.

"2. The greater ease of ingestion of carbon was verified by a new method of measuring phagocytosis, described as the film method, in which the cells ingest particles as they creep about on a slide.

"3. The relative rates of ingestion of carbon and quartz depend upon the condition of the cells, the difference increasing as the phagocytic activity of the cells decreases.

"4. Sponge cells also ingest carbon about 3 times as readily as quartz.

"5. The hypothesis is suggested that the cause of the more rapid ingestion of carbon may be identical with the cause of the greater instability of the carbon suspensions.

"6. An inorganic analogy to this selective phagocytic action is offered.

"7. The application to opsonins and agglutinins is discussed." — C. K. Drinker.

## MENTAL

Experiment to Determine the Possibilities of Subnormal Girls in Factory Work. *Elizabeth B. Bigelow*. Ment. Hyg., April, 1921, 5, No. 2, 302–320. — Aided by the temporary boom in business due to the war, and by the consequent lack of sufficient skilled workers, Miss Bigelow was able to conduct, under the auspices of Professor Arnold Gesell of Yale, a very interesting experiment in determining and increasing the efficiency of subnormal factory girls. The experiment was made in a rubber factory, one of the few remaining industries where the finished product is largely made by hand and where subdivision of labor is still in its infancy.

A tiny "branch" of the factory was set up in a separate room, and there a small group of girls (never more than fourteen) worked every day for eight months under the careful supervision of persons experienced in the psychology of the subnormal. Besides her work record and notes from personal observation in class, a complete case history was made of each girl, and she received the Stanford Revision Tests, and tests with concrete material as well as tests in visual and auditory memory and motor control. Roughly speaking, the girls were divided into

two classes, the imbecile and the moron, their work was appropriately apportioned, conclusions formed and recommendations made. The imbecile group could perform simple, monotonous jobs requiring no skill or mentality. This class is usually dull and inactive and is very little trouble when once trained. The morons, from 8 to 11 years old mentally, are capable of doing work requiring a limited degree of intelligence, and sometimes attain to quite a degree of manual skill. They are usually slow and require constant supervision, for they cannot be relied upon to be as conscientious as the lower group.

Although the number of cases studied was small and the time short, the following conclusions are of interest: It was found that the girls could be trained to take pains up to a certain point, beyond which they could not progress. Neither could they handle work which was at all complicated. Production was affected by physical conditions — lighting, seating, etc., and by change of work (monotonous jobs seemed to suit them best). When given the proper training they were reliable and their personal loyalty was very great. They were apt to be careless and were incapable of planning their work. Curiously enough, the pay envelope did not seem to interest them as much as it does the normal worker, but stimulus could be provided by strict discipline, fear of losing their jobs, and the influence of workers of their own class.

Miss Bigelow recommends that the training of subnormals should be carried on away from other workers by a supervisor of infinite patience and tact, and she is at some pains to explain the best methods for a supervisor to pursue. She urges the enactment of suitable state legislation with reference to subnormals, which would permit them to leave school and go to work prior to the age limit at present imposed in most of our states. Closer co-operation between the schools and the industries would also be desirable and it would be worth while for the state to pay a director for training subnormals where the industries are unwilling to assume the expense.

A vivid description quoted from Carleton Parker will give to the unbeliever some idea as to the value of the subnormal in industry: " 'Look at that Slovak woman,' said the superintendent. She stood bending slightly forward, her dull eyes staring straight down, her elbow jerking back and forth, her hands jumping in nervous haste to keep up with the gang. . . . 'She is one of the best workers we have!' . . . We moved closer and glanced at her face. Then we saw a strange contrast. The hands were swift, precise, intelligent. The face was stolid, vague, vacant. 'It took a long time to pound the idea into her head,' continued the superintendent, 'but when this grade of woman once absorbs the idea, she holds it. She is too stupid to vary. She seems to have no other thought to distract her. She is as sure as a machine. For much of our work this woman is the kind we want. Her mind is all on the table.' " — Stanley Cobb.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Formation of Poisonous Gases by Certain Forms of Gas-Fired Water Heaters. *E. P. Schoch.* Abstracted as follows from Am. Gas Assn. Month., 1921, vol. 3, pp. 131–142, in Chem. Abstr., May 10, 1921, 15, No. 9, 1386. — "It is shown that gas-fired water heaters in which the flames touch the water vessels may produce enough poisonous gas to be harmful and even fatal. Hence such heaters should never be installed and operated without being connected to a flue. Experiments were made on a type of instantaneous water heater, as is often used in bathrooms, where the flame touches extensively upon the metal surface and is cooled thereby below the ignition points of the gases, thus allowing them to escape unburned. The amount of CO formed is somewhat proportional to the areas touched by the flames. The rate of formation of CO is increased also by the variation in the draft of the heater, and by the increase in supersaturation of the air with moisture."

Hemato-Respiratory Functions. XII. Respiration and Blood Alkali during Carbon Monoxid Asphyxia. *H. W. Haggard* and *Y. Henderson.* Abstracted as follows from Jour. Biol. Chem., July, 1921, 47, No. 2, 421, in Jour. Am. Med. Assn., Aug. 13, 1921, 77, No. 7, 574. — "Carbon monoxid asphyxia, Haggard

and Henderson state, induces, not acidosis, but alkalosis. The lowering of blood alkali is due to the acapnial, not the acidotic, process. The anoxemia induces excessive breathing (up to 300 per cent. or more), and the decrease of blood alkali is an attempt at compensation. The rate of oxygen consumption is scarcely, if at all, decreased until death is imminent, but the respiratory quotient may be more than doubled. After section of the vagi, on the contrary, anoxemia due to carbon monoxid causes no overbreathing, and no distinct lowering of blood alkali, even up to death. This fact appears to be a decisive demonstration that oxygen deficiency itself does not directly cause in the tissue and blood an increased production of organic acids." — C. K. Drinker.

T.N.T. Poisoning and the Fate of T.N.T. in the Animal Body. Medical Research Council, Special Report Series No. 58, H.M. Stationery Office, London, 1921. — This report contains a paper by W. J. O'Donovan approaching the subject from the historical, technical, administrative, and clinical aspects, as well as papers on the pharmacology of experimental T.N.T. poisoning, on the metabolism and fate of T.N.T. in the animal body, and on the pathological changes produced by T.N.T. in animals experimentally poisoned and in the human victims of factory poisoning. — M. C. Shorley.

Acute Nitrobenzol Poisoning: Studies on Blood in Two Cases. *R. F. Loeb, A. V. Bock*, and *R. Fitz*. Abstracted as follows from Am. Jour. Med. Sc., April, 1921, 161, No. 4, 539, in Jour. Am. Med. Assn., Aug. 20, 1921, 77, No. 8, 643. — "Two young men bought six bottles of Jamaica ginger from a stranger. Both agreed that this ginger did not taste like ordinary ginger but was drinkable, so that they partook freely of it. On subsequent analysis the liquid was found to contain a high percentage of nitrobenzol. In about three hours after beginning on the first bottle one man began to have generalized headache, nausea and blurring of vision. He thought that he fell on the sidewalk and remembered nothing further until he woke up in the hospital. The other man, at about the same time, began to feel dizzy and nauseated. He did not lose consciousness but came to the hospital with his friend. At entry both men were of a steel gray-blue color, the unconscious man looking particularly dead while his companion was of a ghastly color but in reasonably good shape. There was nothing else especially notable except that neither man excreted any urine for at least hours after entry into the hospital. The stomachs of both men were washed out at once. The sicker man was bled 100 c.c of blood and transfused with 600 c.c. of normal blood. In the middle of transfusion he suddenly woke up and appeared normal. The second man was also transfused, with less dramatic effect. Both men, however, felt perfectly well on the following day and made normal recoveries except that the more seriously poisoned man developed a mild, uncomplicated pneumonia. The oxygen capacity of both bloods on the first observation was markedly reduced, in one case being only 6.2 volumes per cent. The total hemoglobin was not reduced. The fact that methemoglobin was not detected by spectroscopic examination suggests that a large proportion of the hemoglobin was changed to Filehne's nitrobenzol hemoglobin. This combination, in turn, was an easily destroyed compound as demonstrated by the blood analysis made twenty-four hours later. By this time the appearance of both patients was much more nearly normal and the bloods showed no diminution in their total hemoglobin, oxyhemoglobin or oxygen capacity. Leukocytosis developed in one case. The high-colored, almost black, urine excreted by these patients was probably due to para-amido-phenol." — C. K. Drinker.

## DUST HAZARDS AND THEIR EFFECTS

Pneumatic Systems for Removal of Dust. *F. C. Allen, Jr.* Safety Engin., May, 1921, 41, No. 5, 226–228. — Dust is noxious, dangerous, valuable, and its removal is imperative for economic as well as hygienic reasons. The means of removal are: (1) by brooms; (2) washed away with a stream of water; (3) blown by a blast of air (compressed air); and (4) drawn into a duct or conduit by an inflowing air current of suction. The fourth method is the ideal and correct one. Its uses and advantages are briefly described. — M. Dent.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

STUDIES ON TUBERCULOUS INFECTION. VIII. SPONTANEOUS PNEUMOKONIOSIS IN THE GUINEA PIG. *Henry Stuart Willis.* Am. Rev. Tuber., May, 1921, 5, No. 3, 189–215. — The following summary is given: "1. There are anatomic differences between the lungs of old and those of young guinea pigs. These differences concern themselves chiefly with a larger amount of lymphoid tissue in the older animals. The increase in the amount of this tissue apparently parallels the increase in age and in dust content.

"2. Spontaneous pneumokoniosis occurs in guinea pigs that have lived a cage life for a year or longer.

"3. The pigment is laid down under the pleura in spots and lines which mark off the secondary lobules. It is also found in the walls of bronchi and blood vessels, in lymph nodes and lymph masses throughout the lung. In the tracheobronchial nodes it is present in considerable quantity. Practically all of the dust is intracellular.

"4. Lymphatics transport the dust cells but these vessels on section usually appear empty.

"5. A very slight fibrosis occurs in the tracheobronchial nodes, the pleura and the walls of alveoli that are in the regions of the dust deposits." — C. K. Drinker.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

HOW TO TREAT SKIN AFFECTIONS OF EMPLOYEES. *Walter C. Allen.* Indust. Management, March 1, 1921, 61, No. 5, 180–181. — "Furunculosis from contaminated oils and cutting mixtures is widespread in the industrial world. . . . and workers whose hands and arms tend to chap are more liable to these infections than others." To combat cases of furunculosis the author suggests the following steps:

1. Fractional centrifugation, sedimentation and sterilization of all used lubrication and cutting oils intended for re-use.
2. Educating the employees in order to prevent spitting into the oils, and to reduce infection through cleanliness.
3. Provide spittoons, individual towels, and waste and wipe rags.
4. Good washroom facilities.
5. An emollient skin protective to be applied before going to work.
6. A laundry service to provide clean jackets.
7. Dispensary service. — M. C. Shorley.

THE PREVENTION OF SKIN TROUBLES FROM CUTTING OILS AND EMULSIONS. Nat. Safety Council, Safe Practices No. 44, 1921, pp. 8. — Cutting oils and emulsions are used in the process of cutting metal, and are usually a mixture of oils. Lard oil, formerly the standard, is now seldom used in a pure state, but is generally mixed with mineral oils or replaced by other oils. From the use of these oils a troublesome skin affection, taking the form of blackheads, pimples, or boils, is sometimes induced, although some men may work for years and have no serious effects. Men with abundant hair on the arms and those with dry skin are more liable to the affection.

Recent investigations made by E. F. Houghton and Company show that mineral oils treated with sulphuric acid have certain ingredients (principally the organically combined hydro-carbon sulphonates) which lodge in the pores and hair pockets and irritate the lining cells, but that these may not be the only chemical irritants in a mineral oil. The oils of the paraffin series possess irritating properties, and animal and vegetable oils that have a high percentage of free fatty acids are also irritating to the skin. The cutting oils and pastes are usually free from germs when they come from the manufacturer, but are likely to become contaminated in use, although more often the germs concerned in the skin affection are, probably, on the skin. Another factor in causing the trouble is the scratching of the skin by metal chips and particles, and especially by the habit among mechanics of using waste to rub the hands and arms.

There are three rules for prevention: (1) Use a cutting medium with a mineral oil content free from irritants. (2) Keep the cutting fluid clean by filtration and sterilization. (3) Encourage personal cleanliness and hygiene. Oils of vegetable or animal origin used with mineral

oil should be selected with care, and those containing irritating properties should be avoided as far as possible. Mineral oils can now be obtained free, or nearly free, from chemical irritants. Cutting oils that are used more than once should be filtered and sterilized. Filtration is done by running the oil into a filter cabinet, and the best method of sterilizing is to heat to a temperature of 140° or 180°F. for a period of from twenty-five minutes to one hour. Germicides cannot be relied upon to keep the fluid in safe condition.

Personal cleanliness is very important, and it may be said that a clean unbroken skin never becomes infected. Proper washing facilities, with plenty of hot water, soap (preferably liquid or powdered soap), brushes and towels, should be provided. Hard, stiff brushes are to be avoided. Oil should not be wiped off the arms but bathed away in flowing water. To prevent chapping lanolin, vaseline, or similar ointment should be used. Gloves and oil cloth armlets are helpful in keeping out the oil and fine metal particles. Cuts and abrasions should be attended to, and susceptible men should be transferred to other work.

Mild affections may be cured by frequent washing with soap and hot water, and dusting the arms with a powder of equal parts of zinc oxide and starch is good. Dusting the arms with the powder before going to work is sometimes practiced as a preventive measure.

Diagrams of filtering and sterilizing apparatus are shown, and plates illustrating forms of the affection. There is a description of methods of properly installing circulating systems for oil, and the rules of the United States Public Health Service for preventing the skin affections discussed in the article are given. — G. E. Partridge.

Pyrethrum Dermatitis. A Record of the Occurrence of Occupational Dermatoses among Workers in the Pyrethrum Industry. *Carey P. McCord, C. H. Kilker,* and *Dorothy K. Minster.* Jour. Am. Med. Assn., Aug. 6, 1921, 77, No. 6, 448–449. — The authors summarize as follows: "An occupational dermatitis has been found to occur among the workers engaged in the manufacture of pyrethrum insect powder. Chemical analyses of pyrethrum have established various constituents having irritant properties. The lesions noted are, essentially, various forms of dermatitis venenata. They are of mild severity and quickly disappear under ordinary treatment. Re-exposure frequently leads to the re-occurrence of the disease. This dermatitis may be prevented by the introduction of trade processes that eliminate the necessity of exposure of workers to pyrethrum dust and powder." — C. K. Drinker.

A Case of Dermatitis Due to Asparagus. *C. Brenning.* Abstracted as follows from Dermat. Wchnschr., Oct., 1920, Vol. 71, 851, in Arch. Dermat. and Syph., May, 1921, 3, No. 5, 667. "The author reports the case of a patient who suddenly became sensitized to asparagus after having worked with it for eight years. A dermatitis was produced on the arms which after healing was experimentally reproduced by application of asparagus." — M. Dent.

What Constitutes Industrial Blindness? *Edward Stieren.* Nation's Health, June 15, 1921, 3, No. 6, 369–370. — The erroneous idea prevails that the fractions used by ophthalmologists everywhere represent loss of vision. Visual acuity of 20/30, for example, does not represent a loss of one-third of vision, but a loss of 5 per cent. An acuity of 20/40 means 10 per cent. loss of vision, and so on until we reach 20/220 when we have industrial blindness. That is, an eye incapable of reading the 220 foot line at 20 feet is blind in the sense that it is not fit to do any kind of work. The most equitable adjustment of compensation would seem to be to use the percentage basis thus indicated and make payments definitely proportional to the actual degree of loss of vision. — G. E. Partridge.

Superficial Injuries to the Eye in Industry. *Ernest F. Hoyer.* Am. Jour. Nursing, May, 1921, 21, No. 8, 530–532. — Statistics of the State Board of Labor and Industries in Massachusetts show that more than 6,000 cases of injuries to the eyes have been reported during one year. An important rule for nurses is that "all injuries to the eye are serious." The distinction between major and minor injuries is not applied to the eye, and if an injured eye is treated by an unskilled person, disastrous results may follow.

Four kinds of superficial affections of the eye are mentioned and simple treatment explained. These are: foreign body in the eye; conjunctivitis; burns and scalds of the eye; electric ophthal-

mia. The treatment for foreign body in the eye is: cleanse with boric acid solution, one or two drops of cocaine solution, evert the upper lid, remove the foreign body with a small piece of cotton wound on a wooden applicator. Apply a drop or two of 10 per cent. solution of argyrol. Particles lying loose in the conjunctiva or on the cornea are easily removed with a sterilized platinum wire loop fixed to a handle. Conjunctivitis is treated with a 25 per cent. solution of argyrol, followed by irrigation with boric acid solution. The treatment is given three or four times a day. Care should be taken to instruct patients so that they will not infect others. Burns require boric solution, and a drop of 2 per cent. solution of cocaine in castor oil or Nujol. Then as later treatment 2 per cent. picric acid ointment, preceded by a drop of cocaine two or three times a day, should be used. Electric ophthalmia is very common where electric welding is done. There is severe pain in the eyes, swelling of lids, and burning sensation. The treatment consists of saline solution and relief with cocaine solution. Afterwards colored glasses should be worn.

"All kinds of safety eye protectors are in use, but the perfect protector — one that does not cut off too much light, is strong, and does not rust, does not press the face and heat the eye — has up to the present time not been invented." Men will often prefer to take risks rather than wear something uncomfortable, and even after an accident will accept the risk again. An educational campaign would help to produce better co-ordination between safety committee and workingman and better understanding between employer and employee. — G. E. Partridge.

The Economic Aspect in Eye Injuries: A Plea for Early Treatment. *T. Lister Llewellyn.* Brit. Med. Jour., Jan. 22, 1921, 1, No. 3134, 118–120. — This paper is based on an analysis of the total accident claims on North Staffordshire coal and iron owners for the past two years. The author takes as proof for his argument 163 eye cases, in which incapacity lasted four weeks or more and compensation claims were made. If these men had had the foreign bodies removed immediately after the injury much needless waste would have been avoided.

The author summarizes as follows: "What is the position of the workman and employer at the end of the period under review?

"*Workmen.* — Forty-four men have lost the use of one eye and nineteen have developed nystagmus.

| | |
|---|---|
| "Settled for lump sum | 19 |
| "Working full time | 98 |
| "On half difference | 11 |
| "Playing | 35 |

"Time lost at five turns a week 17,250 shifts.

"*Employer.*

"Loss of output corresponding to time lost by workmen.

"Expenditure in compensation, £8,286.

"Liability of sixty-eight unsettled cases." — M. Dent.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Accident-Preventing Education. *H. H. Herdman.* Survey, May 28, 1921, 46, No. 9, 274–275. — During the nineteen months when the country was at war 50,150 American soldiers were killed and 200,000 wounded; and during the same period 126,000 Americans were killed pursuing the arts of peace, and 2,000,000 were wounded. In the city of Portland, Oregon, there were, in 1920, 10,038 traffic accidents and in the logging industry for a two-year period ending in June, 1920 there were 4,245 lost-time accidents.

The Oregon and Columbia Basin Division of the National Safety Council is co-operating with the state school department in a plan for accident-preventing education to be conducted as a part of the state curriculum, the intention being to co-ordinate the work with the subject of civics, which extends from the primary grade through the eighth grade. A course has been prepared by a committee of five teachers, which will emphasize the positive aspects of the subject. — G. E. Partridge.

Industrial Safety Organization. Nat. Safety Council, Safe Practices No. 42, March 7, 1921, pp. 16. — The first five pages of this pamphlet contain the essentials of successful accident prevention; the remainder details suggestions for the safety engineer, the various safety committees, and the foremen.—M. Dent.

Safety Problems of Today. An Interview with W. E. Worth. Nat. Safety News, June,

1921, 3, No. 16, 3–4. — The two big problems of the safety man today are: (1) convincing the management that safety work should be continued without interruption; and (2) maintaining and improving the safety morale of employees.

The cry today in business is economy. Operating departments have been cut and investigations made into the running of the plant with an eye to economy. If the safety department has been unprofitable and badly organized, it, too, should be cut. But the careful, intelligent manager should remember that an accident now is a more expensive proposition than the same accident when his plant was running full blast. And at present, when men do several kinds of work besides their regular job, the possibility of accidents is far greater.

The present slack period gives opportunities to make physical improvements for accident prevention and to re-establish the personal touch with the men which has disappeared in recent years. The safety man must keep the employee from worrying about losing his job, for a man who is worried and absent-minded is prone to accidents.

"The industrial manager who discontinues or suspends his safety work must realize that his failure to 'carry on' is not only poor business, so far as his own property is concerned, but a detriment to the movement as a whole and to the thousands of other employers who have faith in it." — M. C. Shorley.

Safety in Relation to Electrical Appliances. *Dana Pierce.* Safety Engin., May, 1921, 41, No. 5, 206–212. — Electricity may cause accidents in two ways — by shock and by burns; to these may be added the hazards of a mechanical nature. For protection against shock current-carrying parts should be insulated, appliances should be grounded, as should also the enclosure frames and non-current carrying metal parts of equipment. Some rules are given for this sort of protection.

Enclosing apparatus in tight cases, isolating it, providing goggles and protective clothing are advised for protection against burns. The hazards of a mechanical nature are: explosions of fuses, gas or dust explosion, moving parts of a controller, phase reversal, unexpected starting, over-speed, lack of emergency stop at point of operation, over-travel, failure of power, and over-loaded current.

Electricity can be made safe. New inventions should be followed and applied in safeguarding. — R. M. Thomson.

Dehydration Equipment as Safety Field. Safety Engin., June, 1921, 41, No. 6, 283–284. — "To secure the safe and proper construction of dehydrating plants, the following advice is given: 'The dehydrator proper should be built of incombustible material — either brick, concrete or interlocking tile. The shed or structure built over the dehydrator may be of frame, but it should be open, substantially built, and properly insulated from the dehydrator.

"'All air carriers from the furnace, if this system is used, should be of incombustible material. The heating apparatus should be also of such material that it will easily transmit the heat to the surrounding air, and yet will permanently separate the open flame from the air used in the dehydrator. This rule is of primary importance. Where oil is the fuel, sumps in front of the furnaces should be avoided if gravity fuel feed is used.

"'All electric wiring should be in conduit. Fans, when of the blower type, should be protected by a wire mesh screen that will prevent entrance of sparks into the air chamber.

"'Precautions should be taken to have a simple and easily manipulated heat control device which shall be at all times under the observation of the employee whose duty it is to control the air drafts. This, of course, is as essential to the proper preparation of the product as it is for fire prevention.'" — M. Dent.

Dangers from Pulverized Coal. Abstracted from U. S. Bur. Mines, Rep. Investigations, 1921, in Factory, July, 1921, 27, No. 1, 76, 78. — "Since the introduction of pulverized coal as a substitute fuel for natural gas in the various types of heating furnaces used in steel mills, a number of fires and explosions have occurred, resulting in loss of life and property." It is recommended that storage bins for pulverized coal should not be placed in any position where they may become heated; that pulverized coal should not be delivered to bins at a high temperature; and that, if a plant has been shut down for a few days, coal should not be delivered fom the storage bins to the place of consumption until an examination is made to find out whether the coal has become heated to such a point that it will ignite when brought in

contact with a current or blast of air. — M. C. Shorley.

Tests of Miners' Flame Safety Lamps in Gaseous, Coal-Dust-Laden Atmospheres. *L. C. Ilsley* and *A. B. Hooker*. Abstracted as follows from U. S. Bur. Mines, Rep. Investigations, No. 2199, 1920, in Chem. Abstr., May 20, 1921, 15, No. 10, 1424. — "Coal dust powdered to 200-mesh was added to the methane-laden atmosphere of the special gallery at the Pittsburgh Station and its effect on various types of safety lamps noted. Thirteen failures from a total of 50 tests with unbonneted lamps occurred, 2 of which were caused by the presence of coal dust. The authors conclude that unbonneted lamps are less safe in atmospheres containing the dust, and future tests of flame lamps are to include a certain proportion made in dusty atmospheres."

## INDUSTRIAL SURGERY

Focal Infections as Affecting Trivial Injuries. *C. D. Selby*. Mod. Med., April, 1921, 3, No. 4, 229–230. — Trivial injuries are likely to be affected by focal infections, and the relation of infection to these slight injuries presents problems in connection with compensation that need to be considered. We should know what kinds of trivial injuries are most likely to be followed by infection of focal origin, and when injuries of this type occur, foci of infection should be looked for and eradicated. Questions of the validity of claims for compensation for disabilities due to metastatic infection, said to be caused by injuries in themselves not disabling, are often puzzling; but if the injury is proved, the pathology of the affected part definite, and the existence of the focus of infection established, the validity of the claim has presumption in its favor.

The most common kinds of slight injury in which metastatic infections are to be expected are: (1) simple fracture of a terminal phalanx; (2) contusion of the end of a digit; (3) sprain, particularly of the knee, wrist, ankle, elbow, shoulder and hip joints; (4) strain, especially of the back, deltoid and gluteus muscles. All joint injuries and all contusions of the muscles except very trivial ones, therefore, require precautions. The mouth should be examined for bad teeth, the tonsils inspected, the sinuses examined, and the history should be taken for evidence of focal infection, including chronic intestinal intoxication and genito-urinal infection, for which laboratory tests should be made, if necessary. If foci are discovered, they should be removed, if possible. — G. E. Partridge.

Studies in Wound Infection. *S. R. Douglas*, *A. Fleming*, and *L. Colebrook*. Med. Research Council, Special Report Series No. 57, H. M. Stationery Office, London, 1920, pp. 59. — This pamphlet is divided into thee parts: first, a statement of the nature of the cases treated, methods of treatment employed, and some of the conclusions arrived at; second, a detailed account of the characteristics of the various bacteria isolated from the wounds; and third, experimental work bearing upon the action of certain antiseptics in infected wounds. The authors summarize the results of their experimental work as follows:

"1. Two simple cup-shaped wounds have served us as test tubes by means of which the action of certain antiseptics and of hypertonic salt solution — as well as the reactions of the tissues to these substances — could be studied *in vivo*.

"2. The application of eusol, Dakin's solution, and solutions of chloramine T to these wounds, in such a manner as to give the antiseptic the best possible chance of exercising its bactericidal effect, caused no appreciable reduction in the bacterial flora of the wounds. Owing to technical difficulties, the analogous experiment with flavine did not give a clear result, but it can be said that nothing like a complete bactericidal effect was obtained.

"3. The effective strength of eusol and Dakin's solution is very rapidly dissipated by contact with the tissues when applied even to a perfectly clean wound. Within ten minutes their hypochlorite concentration is reduced by at least 80 per cent. and their bactericidal value has become practically nil. Very much the same applies to chloramine T. (It is probable that a still greater loss of strength would have been recorded if these antiseptics had been applied to wounds in which there was a large accumulation of leucocytes, a condition which frequently obtains in surgical practice and, especially, when Carrel's system of intermittent irrigation is employed.)

"In the case of flavine a similar but slower reduction in strength occurs as the dye becomes combined with the tissues of the wounds: and in this case — as with all other dyes tested — a further serious loss of effective strength occurs through fixation of the dye by the cotton and other fabries which are habitually employed for dressing wounds.

"4. In view of these serious drains upon the effective strength of antiseptics in a wound, the question naturally arose — Is there a sufficient amount of the antiseptic agent left in the wound to exercise a bactericidal effect? This problem was investigated by determining the effect of various strengths of antiseptic solutions upon bacteria suspended in serum. In the case of eusol and Dakin's solution it was found that a hypochlorite concentration, comparable to that which remains in a wound 5 minutes after its application, was not only incapable of restraining the growth of microbes in serum but actually *stimulated* the growth of certain types to a very marked degree. In the case of flavine, concentrations of 1 in 4,000 to 1 in 16,000 were found to be necessary to inhibit the growth of Staphylococcus, according to the number of cocci employed for the test — and it appears unlikely that such concentrations as this remain active in the wound for any length of time after the application of a 1 in 1,000 solution.

"The stimulation of microbic growth in serum was not confined to the hypochlorite solutions, being demonstrated also with carbolic acid, iodine, chloramine T, and malachite green solutions. It did not occur equally with all bacteria.

"5. In Section 9 it is shown that all the antiseptics in use have a destructive action on the leucocytes, and this destructive action occurs in a lower concentration than is necessary for a lethal action on the bacteria. Wright, Fleming, and Colebrook have demonstrated the very striking bactericidal efficiency of leucocytes when provided with the requisite conditions for their functioning. In the cavity of a wound to which an antiseptic has been applied such leucocytic destruction of microbes will be put out of action for a time varying with the rate of dissipation of the antiseptic, and in this way it may again happen that the balance of advantage, following the employment of such an agent, will be with the bacteria rather than the patient.

"6. It has been suggested that certain antiseptics, although incapable of exerting a directly bactericidal effect in the wound, may yet contribute something indirectly to the antibacterial processes by provoking a *physiological reaction* on the part of the tissues. It has also been stated as a fact of clinical observation that the separation of sloughs in infected wounds is hastened by the use of Dakin's solution. In this connection our experiments showed that the application of hypochlorite solutions resulted in an increased exudation of lymph which sometimes lasted over a period of several hours — and also that this lymph differed from that normally passing into the wound in that its antitryptic power was much reduced. This latter result may help to explain how the antiseptic has promoted (*sic*) the separation of sloughs. In our experiments — which were done with clean wounds — its application led merely to a diminution of the antitryptic power of the exuded lymph (presumably by disintegration of leucocytes), but in a foul wound full of dead leucocytes, it is probable that the same process would make the discharges actively tryptic, or increase the amount of tryptic ferment already liberated in the wound, and thus lead to the digestion of sloughs.

"In a wound already free from sloughs, on the other hand, it would seem that no useful purpose can be served by the increased flow of lymph of reduced antitryptic power obtained by this means. Wright has shown that what is required in such a wound is not so much a flow of lymph as an abundant emigration of leucocytes and the maintenance of optimum conditions for their functioning. The use of antiseptic solutions is directly opposed to these aims.

"7. The effects of introducing hypertonic salt solution into a wound were studied and found to be as follows:

"(*a*) An immediate and marked increase in the exudation occurring into the wound cavity, this increase being greater than that obtained by the irritant action of any antiseptic solution.

"(*b*) The exudate so obtained did not consist merely of watery fluid, as had been sometimes alleged, but was rich in albuminous substances.

"(*c*) The emigration of leucocytes into the wound was suspended for a time but gradually returned to normal as the sodium chloride concentration of the fluid fell away. An abundant emigration of leucocytes took place when the wound contained physiological salt solution.

"These findings agree in every particular with the results of experiments *in vitro* pub-

lished by Wright in the early days of the war. He also demonstrated very clearly that the disintegrative action of 5 per cent. salt solution upon the leucocytes of pus led to a liberation of tryptic ferment, and upon this basis advocated the frequent application of the solution in the treatment of slough-covered wounds.

"Wright's work, together with the series of experiments here described, enables us to piece together the cycle of events occurring after the instillation of 5 per cent. salt solution into a wound, somewhat as follows:

"First 20 minutes. Rapid exudation of lymph; liberation of tryptic ferment by disintegration of leucocytes present on the surface of the wound, in sloughs, and free in the pus (this ferment, however, will not be able to exert its full digestive effect until the salt concentration has fallen considerably); emigration of fresh leucocytes almost entirely suppressed; concentration of the salt solution falling roughly to one-half its original content.

"Second 20 minutes. Less rapid exudation of lymph, but the antitryptic power has been abolished owing to the disintegration of leucocytes by the salt solution, which has now diffused into the walls of the wound; digestion of sloughs by the tryptic ferment in the cavity of the wound becoming very active; emigration of leucocytes recommencing; concentration of salt solution falling further — to 1.5 or 2 per cent.

"Third 20 minutes. Exudation again less abundant but still more than normal owing to the high sodium chloride content of the tissues; lymph distinctly tryptic; digestion of sloughs proceeding at maximal rate; emigration of leucocytes becoming more abundant; concentration of salt solution nearing the isotonic level.

"Second hour. Little change in rate of exudation — the lymph less tryptic or becoming slightly antitryptic; digestion of sloughs continuing but not quite so actively as before; emigration of leucocytes at normal rate and some of them undergoing natural disintegration, so reinforcing slightly the tryptic ferment. As the wound becomes progressively cleaner the serous exudate will tend to have a greater antitryptic value and will, therefore, be enabled to exert its antibacterial properties upon any sero-saprophytic bacteria that may be present." — M. C. Shorley.

The Treatment of Acid and Alkali Burns. *A. K. Smith.* Mod. Med., April, 1921, 3, No. 4, 232–233. — Strong caustics, when applied to the skin, immediately unite with it, killing the tissues to a depth proportionate to the strength and quantity of the caustic, and the wounds they cause are conveniently classified in the same manner as true burns. First aid must be immediate, and probably the most valuable treatment is the shower bath, which should be used before any attempt is made to remove clothing, in an effort to put a large volume of water between the caustic soaked clothing and the skin. Then a saturated solution of bicarbonate of soda is to be used in the case of an acid burn, and a 2 per cent. solution of acetic acid when the injury is caused by an alkali.

Directions are given for the treatment of injuries of each degree, for shock, and for injuries to the eye by caustics. — G. E. Partridge.

Musculature of Foot and its Treatment by Electricity. *G. M. Levick.* Abstracted as follows from Jour. Orthop. Surg., July, 1921, 3, No. 7, 317, in Jour. Am. Med. Assn., Aug. 13, 1921, 77, No. 7, 575. — "Little describes a method of electrical treatment of the foot which is recommended as a preliminary to voluntary exercise, as inseparable from the satisfactory treatment of flat foot. Often it is extremely difficult or impossible to redevelop the small muscles by voluntary exercise alone. This applies especially to those cases that have been repostured by surgical methods, so that they are suddenly relaxed after a long period of overstretching with its accompanying atony." — C. K. Drinker.

Occupational Deformity of Hand. *K. Pichler.* Abstracted as follows from Mitt. a. d. Grenzgeb. d. Med. u. Chir., 1921, 33, No. 3, 249, in Jour. Am. Med. Assn., July 16, 1921, 77, No. 3, 239. — "Pichler refers to the slanting outward of the fingers in persons who have done much hard work. This shape of the hand is common with old articular rheumatism and in gout, but manual labor, such as carpenter work, is liable to induce it in the healthy." — C. K Drinker.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Relation of Posture to Industrial Health. *Edith Hilles.* Nation's Health, June 15, 1921, 3, No. 6, 339–343. — Manufacturers are just beginning to understand that a comfortable position at work saves energy units and means increased efficiency in production. The good chair alone, however, does not assure good posture. The bench, the chair, foot rest, place for supplies and place for finished work must all be carefully adjusted.

The New York State Industrial Commission gives a general summary of the principles of correct seating as follows: "A seat, broad and not too deep, slightly saddle shaped, and with the front edge rounded; the feet resting comfortably on the floor or on a broad foot rest attached to the floor or bench; the bench at a height to allow plenty of room for the knees between the top of the seat and under side of the bench; no brace or other obstruction interfering with a comfortable position of the feet and legs; a back rest supporting the small of the back and not extending up far enough to interfere with free movement of the arms; supplies arranged so that no excessive reach is involved in the work. If an operator is able to rest herself by changing her position at work occasionally, a great deal of unnecessary fatigue can be avoided. For many operations, the thing to do is to begin by raising the bench and chair high enough to allow the operator to work sitting or standing."

The best material for a chair seat is wood. Cane seats become saggy, and metal seats are too hard or are made with sharp edges. The best depth and tilt for the seat depend upon the nature of the work, as does also the type of back. In general, backs are recommended, and the American Posture League maintains that there should be an open space about 7 inches from the seat floor before the back rest begins. There should be a support at the small of the back at least 2½ inches wide and slightly curved. There is a difference of opinion as to whether adjustable chairs are better or whether chairs should be constructed in different heights and sizes, and again, as to whether a chair should be made so that the worker himself may adjust it, or so that it can be changed only by a shop mechanic. Foot rests should always be provided if the feet cannot rest comfortably on the floor, and should be adjustable and attached to the floor or the bench, not to the chair. Another problem is the sitting-standing bench. The height of such benches, shown in the report of the New York State Industrial Commission on Industrial Posture and Seating varies from 33 to 37 inches. From 6 to 10 inches should be left between the under side of the bench and the seat.

An account is given of a standardized work place adopted in a rubber overshoe plant, and a description of the standards for good posture adopted by the California Industrial Welfare Commission is included as follows: "As far as, and to whatever extent, in the judgment of the commission, the nature of the work permits, the following provisions shall be effective; seats shall be provided at work tables or machines for each and every woman or minor employed, and such seats shall be kept so adjusted to the work tables or machines that the position of the worker relative to the work shall be substantially the same whether seated or standing. Work tables, including cutting and canning tables and sorting belts, shall be of such dimensions and design that there are no physical impediments to efficient work in either a sitting or a standing position, and individually adjustable foot rests shall be provided. New installations are to be approved by the commission."

"So little thought has been given to the problem of posture in industry that at the present time almost any plant can go far in improving conditions by even the crudest attempt to plan the work place so that a fair chance for minimum posture standards is given the worker."

The article is illustrated by thirteen cuts. — G. E. Partridge.

Industrial Posture and Seating. *Edith Hilles* and *Wilhelmina Conger.* N. Y. State Dept. Labor, Bur. Women in Industry, Bull. No. 104, April, 1921, pp. 56. — "Fatigue should be avoided like poison, because, in reality it is posion." The conclusions and recommendations for the avoidance of fatigue reached in this report are:

"First: that posture must be varied. Continuous sitting and continuous standing are both harmful. Ideally, conditions should allow the worker to vary his position at will, because of the rest and the enormous saving of energy

that comes from a change of position during working hours.

"Second: that work conditions should be such that correct posture is possible (*a*) by providing a physiologically good chair; (*b*) by insuring a proper relationship of the different parts of the work place.

"There is no one chair that is best for all industrial processes. To determine what chair is best for a particular process, the nature of the work to be done, the position of supplies and finished work, the equipment at hand, *i. e.*, the height of bench, chair, place for foot rest, etc., as well as the height of the individual worker — all these must be considered. To provide a good chair is not enough; the important thing is to bring all parts of the work place into the best possible relationship." — M. Dent.

Seats for Workers in Factories and Workshops. Welfare Pamphlet, No. 6, London, 1920, pp. 16. — The provision of seats is recognized as an integral part of good welfare arrangements, and the Home Office is empowered to deal with it.

Three types of seats are in question: seats for work that can be done sitting; seats for occasional rest when work must be done standing; seats outside the workrooms for rest during intervals. The aim of every factory should be to have work done sitting when possible. When work cannot be done sitting, provision should be made for occasional resting. In one factory, in which five minutes' rest was taken each hour in a certain operation, output showed no less than a 6.4 per cent. increase in every case, and in four of six cases, carefully estimated, the increase was over 10.9 per cent.

Some general rules for the provision and construction of seats are laid down, but the most valuable part of the report consists of nineteen figures showing improved seating arrangements for various kinds of work, such as standard machine chairs, swinging seat for press operators, adjustable seats, rolling seats, a chair with springs to absorb vibration, a seat for weavers, rest seats and foot rests, etc.—G. E. Partridge.

Industrial Efficiency and Fatigue. *Edgar L. Collis.* Jour. Roy. Sanitary Institute, Jan., 1921, 41, No. 3, 235–241. — The introduction of power-driven machinery brought new problems into manufacturing. Up to now these problems have been concentrated in improving the machinery, while the human machine has been neglected. The object in view at present is to attain and maintain efficiency and health in the human machine. Collis divides the means into two groups: the first concerned with fitting the worker to his work, and the second fitting the work to the worker.

Under the first are: (1) selection of workers, in order to prevent labor turnovers of from 100 to 400 per cent. and the enormous waste in labor turnover to industry which has been conservatively estimated at £16,000,000; (2) personal hygiene — a clean skin promotes efficiency and postpones fatigue; (3) ventilation, which should be contrived to maintain optimum conditions for each process; and (4) food supply.

Under the second heading, fitting the work to the worker, are: (1) adapting height and shape of machinery to the man, instead of accepting the height and shape unquestioningly from the manufacturer; (2) correct seating and varied posture; (3) lighting; (4) study of hours of labor and when rest spells are most efficient.

The author concludes as follows: "A right understanding of and attention to the human machine, its possibilities and reactions, its medical and psychological aspects, will increase well-being and contentment, increase efficiency and production, decrease chronic fatigue and discontent, and with them inefficiency and poverty." — M. C. Shorley.

Is a Fatigue Test Possible? *B. Muscio.* Brit. Jour. Psychol., Vol. 12, Part 1, June, 1921, 31–46. — In conclusion the author states:

"(1) An essential pre-condition of experimentation designed to obtain a fatigue test is the knowledge that different degrees of fatigue are present at certain times. This knowledge can probably be obtained *if* it be accepted that fatigue tends to express itself in relatively poor output. It would then be necessary to develop a technique such that by it either (*a*) factors which interfere with this characteristic expression of fatigue can be eliminated, or (*b*) the presence of interfering factors can be known and their effects upon output precisely determined.

"If this *technique* could be obtained we should possess *in it* a fatigue test, that is, a method by which it could be shown in what degree, if any, fatigue was present at given times, but we should not have a rapid and convenient fatigue test.

"(2) Given any method by which we can determine in what degree, if any, fatigue is

present at certain times, it is justifiable to experiment with the object of finding a rapid and convenient fatigue test. We should proceed largely by the method of trial and error, our object being to find *some* test that would rapidly yield at any time a characteristic result if a given degree of fatigue were present. The only suggested tests that could possibly yield such a result are non-performance tests; and consequently experiments aiming to discover a rapid test of fatigue must work with such tests. If such a test were found, the degree of fatigue present at any time could be determined without a lengthy and difficult analysis of output figures.

"(3) In view of the foregoing considerations it is recommended that the whole fatigue test problem be stated in a form the nature of which may be indicated by the following suggestions:

"(*a*) That the term *fatigue* be absolutely banished from precise scientific discussion, and consequently that attempts to obtain a fatigue *test* be abandoned.

"(*b*) That the problem to be investigated be defined as the determination of the effects of different kinds and amounts of work (activity) upon mental and physiological functions: that is, that the kind and amount of work be correlated *directly* with changes in psycho-physiological functions, and *not* (as at present) *indirectly* by means of 'fatigue.' The various proposed fatigue 'tests' would then be used to determine *effects of activity* and not *the presence or absence of fatigue*. Thus stated, 'fatigue investigation' seems to offer a fertile field for scientific work.

"(*c*) That, so far as practical purposes are concerned, attention should be concentrated on methods, such as motion study, by which the amount of *work* required for a given quantity of output can be decreased." — C. K. Drinker.

## WOMEN AND CHILDREN IN INDUSTRY

Some Effects of Legislation Limiting Hours of Work for Women. U. S. Dept. Labor, Women's Bureau, Bull. No. 15, 1921, pp. 26. — This study of the effects of legislation affecting women's hours of labor in New Jersey and Massachusetts is confined to two industries, manufacture of rubber and of electrical appliances, and includes data in regard to sixty-five establishments. It was found that in Massachusetts, where compulsory reduction of hours was carried into effect, the number of women employed increased 9.2 per cent. during the period considered, while in New Jersey, where no such change took place, the number decreased 3.1 per cent. The proportion of women employed decreased 3.1 per cent. in New Jersey and 0.9 per cent. in Massachusetts. A secondary effect of the reduction of hours for women was a similar reduction for men. More than one-half of the establishments in each state increased both their time rates and piece rates when hours were reduced.

In twelve out of twenty-one plants in Massachusetts, reduction of hours was followed by an increase in production, or maintenance of former production; and eleven out of fourteen establishments in New Jersey reported increased or maintained production. There was no recognizable definite relation between production and the number of hours by which time was decreased. One plant in New Jersey reported an increase in output every time hours were reduced, and in another case reduction of six hours a week in a plant manufacturing electric lamps caused no decrease in production.

In but one instance was there evidence that the limiting of women's hours would restrict their opportunities. — G. E. Partridge.

Hours of Women in Restaurants and Telephone Exchanges in Minnesota. U. S. Dept. Labor, Month. Labor Rev., April, 1921, 12, No. 4, 808. — "In Minnesota hours of work for women are not regulated except in cities of the first and second class," with the result that in small towns restaurant employees work more than the fifty-eight hours a week which is the limit for women workers in the large cities of that state, and telephone operators have, in some small northern towns, been on duty twenty-four hours a day, although nominally working from 6 A.M. to 10 P.M. — R. B. Crain.

"At What Age Should Children Enter Industry?" *H. H. Mitchell*. Am. Child, May, 1921, 3, No. 1, 27–32. — At the present time public opinion is against industrial labor for the 14 or 15 year old child, and Montana has a law requiring 16 years as a minimum. Twenty-seven state legislatures have made provisions for physical examination and many

states limit the occupations open to children. There are other indications that public opinion to a considerable extent recognizes a serious health hazard in wage earning before maturity.

Mr. J. P. Murphy, who reported for the Associated Industries of New York State, says that in the final analysis the physical effects of industrial life upon children will necessarily determine the question when and how children shall begin their industrial careers. But there are certainly other important aspects, such as the educational and psychological sides. There should be a scientific approach to the study of physical effects, fatigue, etc., and to problems such as the possible relation of physiological and psychological changes at adolescence to special requirements as regards nutrition. The higher death rate for tuberculosis in cotton-mill operatives from 15 to 19 years of age, as compared with non-operatives, suggests further investigations among industrial workers elsewhere, where conditions are similar; and, finally, we must have some method of deciding what employment, or under what conditions any employment deprives a child of his proper healthy development. A law excluding all children under sixteen from any employment might be in advance of public opinion, but a law providing for health service in continuation schools for working children would not be.

To study the factors affecting the health of employed children an investigation is now being made upon about 1,200 children in Newark, another purpose being to determine the practicability of health service in the continuation school. — G. E. Partridge.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Paint as an Aid to Better Management. *John Dexter*. Abstracted from Works Management, April, 1921, in Factory, June 1, 1921, 26, No. 11, 1328. — "Paint and color are powerful weapons in the hands of a man whose business it is to control the production of a factory. Used skillfully, they decrease the lighting bill, increase the output, and prevent mistakes. A few dollars spent in paint may well return a hundred times the amount." — M. Dent.

Keeping Factory Temperatures Where You Want Them. *Charles L. Hubbard*. Factory, May 15, 1921, 26, No. 10, 1195-1198. — An important problem of the industrial manager is the washing and cooling of air for ventilation, since proper ventilation is essential to economic operation. Understanding of the problem requires a knowledge of various matters such as evaporation and humidity (which are briefly explained).

The plan and elevation of a typical air washer are shown. "This is placed in the main airway leading to the fan, being located between two heaters. The first of these, or tempering coil, is to raise the temperature of the entering air above the freezing point, and the second, or reheater, to bring the temperature up to the required point for heating and ventilation." The plan of the washing apparatus is also shown. Different forms of spray are used according to the result desired, rain-like sheets being best for removing dust, and a fine mist, since it favors evaporation, being best for cooling. "In operation, the air first passes through the spray chamber where cleansing and evaporation take place, then through the scrubbers and eliminators which remove the coarser particles of dirt and practically all mist or water which is not evaporated."

It is important to know that temperature is not the only factor in producing an agreeable atmosphere. Low humidity gives a sense of coolness, and the difference is more marked if the air is moving perceptibly. The relation between temperature and humidity producing optimum comfort is expressed by the formula $T = (316 - R) \div 4$. The proper humidity for a room temperature of 60° F. is 76 per cent.; for 65° F., 56 per cent.; for 70° F., 36 per cent.; for 75° F, 16 per cent. During the heating season any combination desired may be obtained, as the quantity of moisture absorbed may be regulated by maintaining a proper relation between the temperature of the air passing from the washer and that of the spray water, while the room temperature may be regulated in the usual manner without reference to ventilation. In the summer the humidity cannot be controlled, when the cooling process is due to evaporation, but when the outside air is comparatively dry, sufficient absorption or evaporation may often take place to lower temperature

somewhat without raising humidity too much for comfort. The amount of cooling and the final humidity will depend upon, the relative humidity of the entering air, the fineness of the spray, the amount of water used per unit volume of air, the air velocity and the length of the spray chamber.

Cooling by evaporation of the spray water has decided limitations, but when water is available in sufficient quantities at temperatures ranging from 55° to 60° the air may be cooled by direct transmission of heat to the water without evaporation, and therefore without increasing the humidity. Some further details of air cooling by the process of direct transmission of heat are given, and methods of conducting the water supply, etc., are described; and there are some suggestions about cooling in plants employing electric distribution of power. — G. E. Partridge.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Physical Examination of Employees. *A. W. Colcord.* Proc. Ninth Ann. Congress, Nat. Safety Council, Sept. 27, 1920–Oct. 1, 1920, Part 1, pp. 134–146. — This excellent analysis of the purpose and methods of physical examinations should be read by anyone interested in the subject. Prevention of disease is the aim of industrial medicine. Four lines of approach are suggested: (1) working conditions in the mill; (2) living conditions in the home; (3) finding and arresting disease in its early stages; and (4) adjustment of the man's life to suit his physical condition.

A method of estimating and charting resistance is given, together with a valuable record of special examinations. Finally, there is a summary of the important benefits to be had through examination, with especial emphasis laid on the opportunity to show humaneness in the purposes of the medical department. — Elinor D. Gregg.

Why We Have Physical Examinations at Our Plant. *A. A. Bureau.* Factory, Nov. 15, 1920, 25, No. 10, 1575–1577. — Physical examination of workers is one way of controlling the number of accidents and the cost of production, and it should be regarded as an essential part of an industrial organization. The examination of the future must, however, take a broader scope than that of the present. The work must be more thorough, more emphasis must be placed upon the grading of workers in respect to physical fitness for the particular work they do, and there must be more reconstruction work.

The writer describes briefly the plan of the physical examination system conducted by Morris and Company. The first step in the elimination of the unfit is taken by the employment manager, who selects and hires the men who are suitable. The physical examination takes place usually after the men have been placed at work. By this plan the attitude of the men toward the examinations is made more receptive, and the relations between the medical department and the men are put on a better basis, the aim being that the medical examiner shall need to reject but few men as unfit. The men do not usually object to examination when they have been hired, and the examinations, on this plan, can be carried out more thoroughly and with more reference to reconstructive work.

The results of the examination of 855 men are shown on a percentage basis with reference to defects. Thirty per cent. of the men had flat feet; 13.4 per cent. organic heart disease; 11 per cent. poor vision in both eyes; 9 per cent. hernia; 9 per cent. piles; 8 per cent. defect of hand or arm; 7 per cent. varicose veins; 4 per cent. defect of feet; 1 per cent. blindness in one eye; 0.7 per cent. venereal disease.

The finding of unsuspected defects is the greatest good that can be derived from a physical examination department. If for no other reason, this aid to the individual employee will justify the existence of physical examinations in every industrial organization. Physical examinations are not conducted to bar men from industry but to place them where it is best for them to be for the sake of their own safety and well-being. — G. E. Partridge.

Medical Department Directs Library. *Harriet J. Fort.* Hosp. Management, May, 1921, 11, No. 5, 70, 72. — The article describes the activities carried on by the Maryland

Casualty Company for the welfare of its employees, in which, apparently, the work of the industrial nurse is the co-ordinating factor. The lunchroom, infirmary and library are described, and there are some useful models for reports, etc. The nurse intending to do industrial nursing is advised first to obtain experience in public health work. — G. E. Partridge.

Planning the Industrial Dispensary. *H. L. Davis* and *T. H. George.* Hosp. Management, March, 1921, 11, No. 3, 64–65. — Views and a floor plan of the dispensary in one of the plants of the Aluminum Manufacturers, of Cleveland, are here shown. The dispensary was planned from the beginning by medical directors and architects together, and attention was given to placing it with reference to time-saving on the part of the workers, and so that it should have a direct entrance upon the street. There is a main dispensary room, separate rest rooms for men and women, a doctor's office, a dentist's office, lavatories and a store room. The whole equipment occupies a space of about 54×18 feet. The arrangement of hand and foot baths, dressing tables, instrument cabinet, supply closets, etc., has been planned with reference to economy of effort and efficiency in handling cases. Ventilation is direct, from windows opening over steam wall coils. Windows have dust-proof screens, the floor is of smooth cement construction, and all furniture and equipment are white enamel with nickel trimmings.

For details of the medical and surgical equipment the article should be read. — G. E. Partridge.

The Location and Equipment of Modern Industrial Dispensaries. *A. J. Lanza.* Personnel, April, 1921, 3, No. 4, 1–2. — Industrial establishments differ so widely that it is impossible to outline a standard equipment, but fundamentally injuries are alike, and the scientific principles of their treatment do not vary. "The special province of the industrial physician is not that he brings to bear in an injury case a form of treatment differing from the treatment of injuries elsewhere, but that his position and special knowledge make possible prompt treatment, the reduction of lost time and continuous effort along the lines of prevention." Promptness is an essential in industrial cases, and promptness depends upon discipline in the shop and humane and courteous treatment in the dispensary. Compared with this, equipment is secondary in importance.

Suggestions are offered in regard to equipment, and lists of articles needed, including general equipment, instruments and medicines, are given. — G. E. Partridge.

Equipment and Personnel for Care of Injuries. *A. J. Lanza.* Nat. Safety News, Feb. 21, 1921, 3, No. 8, 9, 14. — No fixed rule can be made for the equipment of an industrial dispensary, since location with reference to outside facilities and other variable factors must be considered. No plant is so small that provision cannot be made for the prompt treatment of all injuries. A minimum equipment consists of iodine solution, sterile gauze in small packages, some assorted bandages, a roll of adhesive plaster, a pair of seissors, and a tourniquet. Telephone numbers of the physician to be called, the ambulance, etc., should be prominently displayed. Those in charge of first-aid equipment should know how to apply a tourniquet, and how to administer the Schäfer prone-pressure method of artificial respiration. There should be placed near the first-aid equipment a printed placard setting forth how wounds, burns, and foreign bodies in the eye are to be treated. Medicines should not be kept on hand, and the first-aid man must not try to practise amateur surgery.

In the moderate-sized plant there should be a room at least 12 feet square set aside for dispensary purposes. There should be running hot and cold water, a dressing table, instrument case, spotlight, closet, and cot near at hand. Where there are women employees there should be a rest room. The dispensary should have a trained nurse in attendance at all times during the shift, and the management should insist that a record be kept of everything done for each employee who goes to the dispensary. Once a month these records should be summarized in a report showing the number and type of injuries by departments, and a copy of the report should be furnished the plant manager and the head of each department. A series of such reports is a good index of the efficiency of the safety work. The physician usually comes to the dispensary each day, and he should set forth a routine treatment for wounds of various types, burns, etc.

A plant employing 1,000 men should engage a full-time physician, and, indeed, many plants

employing between 500 and 1,000 men have found it advantageous to do so. The large plant should have, besides the dispensary proper, a room for cots for injured men, a separate office for the physician, and another room for the clerk in charge of records and forms. An X-ray equipment is desirable. Where physical examinations are made a room is usually set aside for this purpose. It should have a measuring device, scales, eye chart, etc. — G. E. Partridge.

Reporting Slight Injuries. *R. P. Matthys.* Hosp. Management, April, 1921, 11, No. 4, 66. — In the Pullman Company the policy regarding slight injuries is to have very simple first-aid equipment — bandages, adhesive, picric acid pads and a pair of scissors. This simplicity usually results in at least one dispensary visit for all injuries, whence they can be inspected and passed on if they are serious. Safety bulletins posted throughout the plant give graphic pictures of the results of neglect and the safety committee men all urge prompt care of small injuries. — Elinor D. Gregg.

Dental Dispensary in Magneto Plant. *A. D. Rood.* Hosp. Management, Nov., 1920, 10, No. 5, 56. — The American Bosch Magneto Corporation has established a system of medical supervision which not only includes the treatment of industrial casualties occurring throughout the plant, but also assumes a medical and dental responsibility in treating both employees and their dependents in the home as well as in the factory. The work, which is in charge of a full-time physician and a half-time dentist and two registered nurses, is herewith briefly summarized. — L. A. Shaw.

California Associated Raisin Company Dental Service. *H. L. Brownell.* Mod. Hosp., May, 1921, 16, No. 5, 467. — The nature and organization of this dental service is briefly described. — L. A. Shaw.

The Framingham Demonstration. No. 25: The Industrial Clinic. *Halstead G. Murray.* Bull. Nat. Tuberculosis Assn., 6, No. 7, 4. — The Framingham industrial clinic consists of a waiting room, a treatment room, a physician's room, an examining room, and two rest rooms — one for men and one for women. Small injuries involving no loss of time are treated in the clinic, while other injuries are usually referred to the home physician for treatment. All accidents are reported to the safety engineer, but only minor accidents are treated in the clinic. Defects which can be remedied are explained, and persons suffering from undernourishment may obtain food. Records are kept of all visits, showing the duration of illness and the most frequent complaints. This enables the doctor to follow up previous advice and to co-operate more satisfactorily with outside doctors.

For membership in the Relief Association a physical examination is required. Consultants from the Community Health Station are available. Health tags on the prevention of simple ailments are given out during the year. Contagious disease is carefully watched for by the physician and nurses, and their work is made more effective by the co-operation of the local board of health. Sanitary conditions are also continually watched and reported upon. The local physicians give their co-operation, and frequently ask that certain treatment be given at the clinic. The importance of regular medical examinations is stressed and everything that can possibly be done through education is undertaken. — Elinor D. Gregg.

The Functions and Scope of an Industrial Clinic in a General Hospital. *Harry Linenthal.* Jour. Am. Med. Assn., March 12, 1921, 76, No. 11, 701–705. — Linenthal outlines the duties of the industrial clinic and discusses cases of skin diseases, respiratory diseases and occupation strains which are not instances of specific occupational disease in the ordinary acceptance of the term, but which are all directly related to the patients' work. He remarks that were the function of the clinic confined to handling lead poisoning and similar direct problems its conduct would be easy, but its usefulness proportionally limited, since "the great function of an industrial clinic is to trace the part industry plays in producing the more common diseases seen in all classes in the community." Such an end can be reached only through the employment of physicians well-trained clinically and at the same time thoroughly informed as to very varied industrial environment. — C. K. Drinker.

The Function of the Plant Hospital. Hosp. Management, Feb., 1921, 11, No. 2, 58, 60. — The annual report of the hospital department of Fairbanks, Morse & Company shows a

proportionate decrease in the number and severity of injuries and an actual decrease in time lost during the past year, due to the excellent spirit of co-operation on the part of the employees, foremen, superintendents, and the safety and hospital departments. The hospital department is equipped to take care of the first treatment of all cases injured in the plant and of subsequent treatment of ambulant patients, but patients requiring hospital care are placed in outside hospitals as there are no beds at the plant hospital.

A special feature of the safety work during the year was an investigation of work shoes, as a result of which a shoe was adopted and sold to the employees. — Elinor D. Gregg.

Plant Hospital Essentials. *J. S. Dye.* Hosp. Management, April, 1921, 11, No. 4, 66. — The essentials of a plant hospital, according to the Chase Metal Works' surgeon, are as follows: (1) central location of hospital; (2) proficient and adequate personnel; (3) sufficient equipment; (4) adequate records; (5) right attitude and approach to patient; and (6) co-operation with other departments. — Elinor D. Gregg.

Employes Plan a Hospital. Hosp. Management, Nov., 1920, 10, No. 5, 64. — The employees of the Shepard Electric Crane and Hoist Company, Montour Falls, New York, plan to establish a fifteen-bed hospital through the Employes' Relief Association. The hospital is for the use of employees, their families, and the general public. Members of the Relief Association will have preference for service, and will receive a discount. The company has promised to pay into the hospital the amount that it now costs to maintain its first-aid service, and will send all injured workmen to the hospital. — M. Dent.

Hospital Department of Industrial Plant Supervises Safety Work. *Sanford DeHart.* Mod. Hospital, Jan., 1921, 16, No. 1, 74-77. — The R. K. LeBlond Machine Tool Company has placed the accident prevention of its plant under the supervision of the hospital department. The prevailing hazards occurring in a machine tool plant and the methods pursued in reducing accidents and absenteeism are herewith described. That the system employed has been highly successful is shown by the fact that absenteeism due to injuries is approximately 7.7 minutes per year per man. — L. A. Shaw.

Matron Service for Plant Hospital. *M. Z. Westervelt.* Hosp. Management, March, 1921, 11, No. 3, 66, 68. — The hospital of the Winchester Repeating Arms Company, of New Haven, consists of a suite of ten rooms — waiting room, emergency room, operating room, women's ward, men's ward, X-ray room, stock room and drug room, doctor's office, dressing and retiring rooms for men and women, respectively.

An important part of the medical department work is that of the matrons, who make two complete rounds of the plant each day, each matron reporting to the hospital every twenty minutes her findings for the preceding period and her route for the next period.

Every employee receiving an injury, however slight, is required to report to the office at once, and a continuous propaganda is kept up to impress the importance of immediate attention to all injuries, the resalt of this being that in four years, during which hospital cases have at times averaged between 300 and 400 a day, there have been but two cases of loss of members from infected wounds.

An accident report is made of every case, which includes an account of the manner in which the injury was received, the diagnosis and the treatment received, the report of the safety engineer, and finally the entries of the Compensation Division, where the report is filed. During the year 1920 there were 13,456 new injuries, and 10,091 cases of sickness cared for. Out of these new injuries, only 245 became lost-time injuries, and only 118 became compensation cases — that is, lost seven days or more. This record is attributed to the fact that the injuries "even as small as a slight scratch" are taken care of at once. The reduction of lost-time injuries, since the installation of a full-time physician, has been 81 per cent., and of compensation cases 60 per cent. — G. E. Partridge.

Michigan Mutual Liability Company Service. *H. N. Torrey.* Nation's Health, June 15, 1921, 3, No. 6, 363-366. — The Michigan Mutual Liability Company is a mutual organization of many Michigan employers. It maintains its own surgical staff both in Michigan and in the city of Detroit, and has a large hospital. The state has been divided into zones and the

aim is to maintain the closest possible relations between the local work and the central organization. The plan is to use local service as far as possible both in city and state, but to make the facilities of the central hospital available when necessary.

The organization of the industrial hospital is shown by diagrams, and the work of the various departments is also described. Special attention is given to physiotherapy, occupational therapy, and rehabilitation. Occupational and vocational therapy consists of the teaching of various practical arts, elementary shop work for ambulatory cases, advanced shop work at various factories for the slightly disabled, reeducation for other vocations. A "rehabilitation man" helps to solve difficult problems of rehabilitation and placement of men for training or work during recovery. There is also a social service department. Among the professional departments the dental and the neurological are emphasized in the report. The industrial clinics do not yet appreciate the great aid that can be rendered by the expert neurologist and psychiatrist in the diagnosis and treatment of many cases.

The keeping of records, the outpatient department, and plans for a new hospital building of six stories with rooms for 100 beds are described. — G. E. Partridge.

Plant Has 24 Hour Medical Service. Hosp. Management, May, 1921, 11, No. 5, 64-65. — Continuous medical service is provided for the employees of the Newport Company of Milwaukee which operates several plants. The hospital of one of the plants is described as a fully equipped establishment having five rooms, with the services of two medical men always available, and having three full-time nurses besides two visiting nurses. When the plant is running with complete forces, there are about 2,000 employees. Six thousand treatments were given during the past year, and pathological investigations have been carried on in the plant to determine the effect of dyes and chemicals. — G. E. Partridge.

Copper Company Has 56-Bed Hospital. *F. T. Hogeland.* Hosp. Management, Dec., 1920, 10, No. 6, 56-58. — This is a description of the hygienic difficulties which the medical service of the Cananea Consolidated Copper Company encounters with its Mexican employees, and the solutions which it attempts. The company supplies medical service to the men and their families at cost, and is doing its best to introduce physical examinations (which the American workmen accept and the Mexican refuse), maintain inspection, and educate its employees hygienically. — M. Dent.

Ship Yard Has 3 Hospitals. *F. C. Leupold.* Hosp. Management, Nov., 1920, 10, No. 5, 59. — A brief outline of the hospital organization of the New York Shipbuilding Corporation of Camden, New Jersey. — L. A. Shaw.

Field Hospitals in Construction Work. *J. P. Cleary.* Mod. Med., April, 1921, 3, No. 4, 230-232. Field hospital service has now extended far beyond its original purpose of rendering first aid to the injured, and includes the care of the general health of the workmen, social welfare and determining the fitness of the man for his work. The field hospital has advantages in making quick diagnoses and administering early treatment and aid which more than offset its cost. To be of the greatest value, the field hospital should be centrally located, and whenever possible the employment department should be in close proximity to it in order to facilitate the examination of applicants for work. The physician can be of the greatest value to a construction organization if, by proper attitude toward the workmen, he can gain their co-operation. The field hospital in construction work, by examining applicants for contagious and infectious diseases, heart lesions, impaired vision, etc., protects both the men examined and others. This work is especially important in some of its aspects, since construction has many more hazards than exist in industries engaged in operation.

In the construction of a large plant, the du Pont Engineering Company employed from August, 1919, to August, 1920, 17,000 men, with a maximum at one time of 3,600 and a minimum of 800. During the year there were 4,490 injuries, including 3,500 medical cases; and 11,219 treatments were given. The cost of maintaining and equipping the plant hospital was $6,800, of which $5,900 was applied to the treatment of minor injuries and medical cases. The average cost of these treatments was 60 cents. The cost for the protection of each man employed was estimated as 37 cents. — G. E. Partridge.

## INDUSTRIAL NURSING

What the Industrial Nurse Does. Pub. Health Nurse, April, 1921, 13, No. 4, 199. — These notes give an outline of the activities of an industrial nurse in a small community. Sanitation, social welfare work, first aid, home nursing and a small hospital in connection with the first-aid room are the chief activities. In the small plants the nurse must of necessity do work of greater variety and less volume in each line. — Elinor D. Gregg.

Industrial Nursing in the South. *Ruth A. Dodd.* Pub. Health Nurse, Feb., 1921, 13, No. 2, 86–88. — The author presents the problem of the industrial nurse in the South, where her field includes everything, and where she must be an amalgamated specialist. The work is primarily that of educating a proud and sensitive group of native eight-generation Americans to a higher standard of living. First aid is only one entering wedge to the family life and habits.

In South Carolina there are state organizations to which the nurse can appeal, though most of the time she works alone. There exists a fine spirit of co-operation among these state agencies, and the county unit plan of development has been followed with success. This gives the nurse a broader field and a broader outlook, greater resources and a firm backing. To the people it means a wider, more intelligent and efficient service. It means a state organization which will be of untold value in improvement of health conditions. It presents for national use and information an immense amount of data as to ways and means. This joining of forces in South Carolina shows a broadness of vision and a unity of purpose from which alone can be evolved the highest type of Americanism. — Elinor D. Gregg.

Industrial Nurses in Metal Mining Communities. *George Martinson.* Mod. Med., March, 1921, 3, No. 3, 186–187. — In the metal mines of Minnesota the greater number of laborers are foreign. Mr. Martinson believes that one of the main duties of the company is to give the employee the trinity of true life — laughter, love, and work. In selecting an industrial nurse technical skill and professional training are considered only as one factor in her fitness for her job. Of equal moment are her personal education and background, her tact and friendliness.

The policy of Pickands, Mather, and Company is summarized in its instructions to the nurse on beginning her work: "Here is where our people live. Go out and do your best to keep their bodies healthy and their minds free from worry. Sympathize with and help them in their sorrows. Try to leave each home happier because you were there, and, finally, try to inculcate in them the spirit of love not only within the family but for their neighbors and for America. Remember always, that in their eyes *you* are the company."

This policy is so often taken as a matter of course and all the emphasis laid upon professional skill, method and judgment that it is refreshing to find an occasional expression of the personal qualities that make for a successful industrial nurse. — Elinor D. Gregg.

## INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

Advantages of Proper Bathing for Workers. *J. L. Mason.* Safety Engin., Feb., 1921, 41, No. 2, 60–62. — Rheumatism and colds are often contracted by men engaged in dusty, sweaty processes, who have long distances to ride home in their damp working clothes because they have no facilities for changing and washing at the factory. The time to bathe is immediately after work, and it is the duty of mills and factories, both from the moral and the physical standpoint, to provide showers for their employees. — M. Dent.

The Home and the Industry. *A. H. McQuilkin.* Indust. Management, Dec. 1, 1920, 60, No. 6, 435–436. — Industrial housing has become an important part of the work of industrial management. The modern aim is to build "homes" suited to the needs or wishes of the occupants, with easy terms of payment and with the least possible limitation of the independence of the worker. The modern idea also is to achieve standardization — not in uniformity of building, but one "through which there are no problems that are not anticipated

and provided for as a result of accumulated experience in design, construction, and material, out of which economy is secured, unnecessary waste avoided, and individuality of the buildings maintained." The great need for buildings of all kinds at the present time has caused an immense effort to discover and test new processes and materials, and new economies.—G. E. Partridge.

Methods of Selling Houses to Employees. *L. H. Allen.* Indust. Management, Dec. 1, 1920, 60, No. 6, 427–432.—This paper considers a proper selling plan to overcome such an evil as the housing of employees by employers at a loss—a condition which causes the real estate values in the community to depreciate.

"A house that is built for sale to a workman should be a single house containing not less than five or more than six rooms, and should be situated on a lot of at least 4,000 square feet. Such a house, including plumbing, electric lights, and hot air heating, on an improved lot with water supply, sidewalks, sewers and roads, will cost today between $6,000 and $7,000." Generally speaking, an original investment of $500 is to be expected on the part of the buyer, and it is usually assumed that a man who cannot save that amount is unpromising. In the case of the average buyer, arrangement should be made for monthly or weekly payments against interest, taxes and reduction of principal, since the ordinary workman understands no other kind of financing and is likely to get into trouble otherwise.

Various other recommendations are made: that the buyer be protected against loss if he wishes to sell and leave town; that the employer be allowed to protect himself if prices rise, retaining an option on the property that can be exercised in case the owner wishes to dispose of it; that some of the houses built for sale be offered to the public at about 15 per cent. in advance of the price made for employees; that a manufacturer's housing development be handled by a subsidiary company under another name. Another promising plan is the co-operative housing plan, which was adopted by the English Garden City companies and which is now being tried in several New York apartment houses. A company is organized to purchase and develop real estate and each stockholder has tenant's rights in one house. This plan may also be adapted to the housing of employees. The advantage of co-operative ownership to the tenant is that he has the freedom of the tenant and yet shares in the profits of the landlord; and he acquires by instalments a liquid investment in a housing property. "It is generally agreed that the workman who owns his own home is the better man for it. The restless dissatisfaction that characterizes the workman of today is replaced by a steady contentment."

The article is illustrated with photographs of houses and groups of houses, and contains a variety of plans for payment which have been worked out in detail.—G. E. Partridge.

How Municipalities, Corporations and Communities Are Solving the Housing Problem. *W. Gibbs Astle.* Indust. Management, Dec. 1, 1920, 60, No. 6, 425–427.—Poughkeepsie, New York, has a Housing Corporation aiming to raise a fund of $400,000, half of which is to come from merchants and manufacturers, and half from citizens in general. Houses will be built on a gradual payment plan, the local bank taking 60 per cent., the Housing Corporation, 30 per cent., the buyer making an initial payment of 10 per cent., and paying the balance at such a rate as will give him his home free from mortgage in about eleven years.

Morgan Park, where the superintendents, foremen, and skilled men of the Minneapolis Steel Company live, is an example of well-designed house planning. Especial attention has been given to fireproof construction and to low maintenance cost.

The United States League of Building and Loan Associations is back of a plan to establish a Federal "Home Loan" Bank system, similar to the Federal Farm Land Bank system. The purpose is to facilitate further building by providing for building and loan associations a way of borrowing money on their mortgage holdings up to 80 per cent. of their value. In support of the plan it is pointed out that the system is simply accomplishing for the builder and home owner what the Federal Reserve Banks and the Land Banks do for the farmer. "The fact remains, however, that a system designed primarily to aid non-productive expenditures is a novel experiment in American banking."

The Province of Ontario, Canada, is assisting municipalities within the province by loans; during 1919, 1,184 houses were built, of which 800 were six-roomed houses, and all but 124

were detached houses. There are other practicable plans in operation, such as that of the Firestone Tire and Rubber Company of Akron, Ohio, which enables employees to own homes by making small payments. Another company provides the amount above mortgage that will enable the employee to build or own his house, and, in general, it can be said that these efforts to aid house builders have been made without profit on the part of the companies, except in the increased efficiency and contentment of the employees. — G. E. Partridge.

Miners' Housing. Brit. Med. Jour., April 9, 1921, 1, No. 3145, 539. — The National Housing and Town Planning Council issues a weekly record for the benefit of the housing committees of local authorities. It asserts that part of the unrest found in the mining districts may be due to improper housing conditions; that local authorities must co-operate with the state; and that the majority of employers are indifferent. These assertions are herein questioned. — L. A. Shaw.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

Survey of General Conditions of Industrial Hygiene in Toronto with Results of an Investigation into Lost Time Due to Sickness. Associate Committee on Industrial Fatigue, Council for Scientific and Industrial Research, Ottowa, 1921, pp. 23. — It was found that, although there is a widespread recognition of the value of good working conditions, the ideas about these conditions are indefinite, and there is little appreciation of the fact that they are capable of scientific determination. There are very few industrial physicians — and most of these part-time men devoted mainly to the treatment of disease rather than to prevention. Managers install various kinds of welfare activity, as a business proposition, or to attract employees, or simply to be abreast of the times, but with little clear purpose in view. There are various obstacles to the extension of industrial hygiene, such as disinclination to accept the experience of other countries, opposition from the employees themselves, and particular difficulties due to post-war conditions, such as the belief that the time is unpropitious for new schemes. The first step usually taken toward promoting health and efficiency is the establishment of a visiting nursing service, but even this has its difficulties, which arise especially from the fact that employees live so far from their work.

In the plants studied, the forty-eight-hour week is most common, and apart from bakeries and dairies, night work is rare. One plant only has a full-time physician, twenty-four have nurses, and some have one nurse for both dispensary and visiting work. Where one room only is provided, equipment and supplies do not usually exceed the requirements of the Workmen's Compensation Act. There is no plant where physical examination is conducted periodically or on change of occupation within the plant.

Artificial means of ventilation are common, and in the larger plants heating is central and therefore clean and efficient, but except where the manufacturing processes require it, no serious attempt to raise the humidity was observed. Individual drinking cups were not noticed but the common cup is still prevalent, although there are some vertical fountains. Conditions in respect to lavatories are bad, and "in comparatively few instances are the recommended standards for number and construction, ordinarily considered the minimum requirements, complied with."

No firm in Toronto has systematic job analysis and compulsory physical examination, but there seems to be general agreement that there is no general fatigue from too long or too strenuous work. Many obvious errors in posture were observed, and fatigue from complicated motions in work was discovered in some instances. In three plants, rest periods had been introduced, and other improvements, such as the examination of employees subjected to unusual eyestrain and the provision, without charge, of suitable glasses, were recorded. Occupational diseases have not become a problem in the city, and there is a general lack of recognition of the occupational factor in disease.

Cafeteria or other systems of serving hot refreshments were provided in eighteen plants, and recreation or rest rooms in nine, but dressing rooms and lockers in the majority of the establishments visited were inadequate.

Special study was made of lost time from

sickness, and the results are shown by four charts. — G. E. Partridge.

The Inspection of Bakeries. *René Wibaux.* Rev. d'hyg., March, 1921, 43, No. 3, 178–184. — This paper recounts the insanitary conditions found in an investigation of the bakeries of Lille. The baking process is carried on by hand and entirely in cellars, where generally the only light comes through a bulkhead which is also used as a means of egress. Apparently the germs from dirt and infected water are not to be worried over as they are killed when the bread is cooked, but the danger to the health of the workmen is great. Many of them are tuberculous, and the germ is, moreover, to be feared in the bread. In 1914 the mortality of bakers from tuberculosis was 37.5 per cent. per hundred.

The author gives some disgusting details of the insanitary practices in vogue among bakers; statistics as to the sanitary conditions of kneading troughs, funnels for conducting flour, walls, ceilings, and floors; and concludes with the statement that there is a hiatus in the legislation somewhere and that the supervision should be increased. In the meantime, patronize the lesser evils among the bakeries and start schools for the study of baking where hygienic processes may be taught. — M. Dent.

## INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

Taylorism and Industrial Supervision. *A. Bender* Zentralbl. f. Gewerbehyg., March, 1921, 9, No. 3, 69–72. — Many of the essentials of the Taylor efficiency plan in industry and the aims of the governmental industrial supervision are identical, as, for instance, in the care of women and minors, the selection of employees for tasks, accident and sickness prevention, diminution of fatigue, and adjustment of compensation to avoid driving employees too hard. The various factors concerned in getting employees and employers to see that the means of improving the conditions of labor and living of the workmen are desirable, economically and humanely, are discussed. — E. L. Sevringhaus.

Mental Science and its Importance to the Industries and to Commerce. Nat. Assn. Corporation Training Bull., Jan., 1921, 8, No. 1, 4–5. — The army tests have resulted in some startling conclusions, and if we apply the results of the tests to the country as a whole, the inferences are discouraging. "It is clear that if a total of only thirteen and one-half per cent. of all the people in the United States can secure an intelligence rating of B or higher, the great masses must work under the direction of the relatively small percentage, and the importance of having those of high intelligence direct the industries and commerce cannot be overestimated." — G. E. Partridge.

Winning Employes to Physical Tests. *A. L. Curtin.* Hosp. Management, May, 1921, 11, No. 5, 66, 68.—Within the past few years physical examination of all applicants for employment has become a matter of routine in some of the largest and best industrial plants in the country. The purpose is to protect the men — both the applicant and the man on the job; moreover, a healthy, efficient working force is the best investment any company can have. Examination should be requested of all "forcefully and rationally," making it practically impossible for anyone to refuse. Examination should not be made for the purpose of discharge except in rare cases. Men should be examined when beginning work, and thereafter quarterly, semi-annually, or annually depending upon the hazards of their occupation. — G. E. Partridge.

## INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Does Welfare Work Pay? *D. W. K. Peacock.* Factory, June 1, 1921, 26, No. 11, 1336. — Welfare work has come to be considered as a charity. This point of view should be abolished. Welfare work will pay if every employee is considered as a member of a great industrial family and taken care of as such. — M. Dent.

Plant Disability Funds. *Charles M. Mills.* N. Y. State Dept. Labor, Bull. No. 105, April,

1921, pp. 16. — This bulletin deals with the problem of providing sickness and death benefits for employees. — M. C. Shorley.

A Plan for Sick Leave with Pay. *M. R. Machol.* Indust. Management, Dec. 1, 1920, 60, No. 6, 453–454. — There is no established method or policy in respect to sick leave, and there is no legal or moral obligation to make an employer pay for the time of an employee which he does not receive. It has, however, long been the custom to take care of salaried employees during illness, at least for a limited time, in order to retain their goodwill.

To put the question of sick leave on a uniform basis, the writer offers a plan for a notice, containing thirteen items, and too complex to quote. Its main features are as follows: Sick leave, with pay, is to increase with length of service after the first year, one week for each completed six months of service, and the time allowed is to be cumulative. Sickness must be reported immediately. In exceptional cases special consideration may be recommended by the department head. In the case of the death of an employee, all sick leave with pay due that employee is to be promptly paid to his or her estate. Termination of service cancels all accumulated sick leave, although if the employee returns he is to be credited with the balance of sick leave due him. Present employees will be credited with about 75 per cent. of the amount of sick leave that would have been standing to their account if this standard had been in force during the entire term of their service.

Such a plan, the writer asserts, has many advantages. It prevents argument, rumor and criticism, and it discourages absenteeism, except for adequate reasons. A declared policy would be a help in obtaining new employees and in inducing former ones to return. By no means the least of its advantages is its effect in reducing the amount of labor turnover. An employee hesitates to throw away his accumulated sick leave by making a change. — G. E. Partridge.

Plant Lunch Room Health Factor. *Sanford DeHart.* Hosp. Management, Jan., 1921, 11, No. 1, 62, 64. — The author states that the Napoleonic phrase, "An army travels on it's stomach," is penetrating industry. The restaurant idea grew largely out of war experience. The results of cold lunches are bad, but the direct and indirect benefits of hot ones may be classified as follows:

1. Marked improvement in health of workers.
2. Less sickness.
3. Less absence and broken time.
4. Increased efficiency and output.
5. Saving time of worker.
6. Salutary change from workshop.
7. Less tendency to alcoholism.
8. Greater contentment of worker.
9. Better mid-day ventilation of workshop.
10. Increase of recreation and games in spare time.

The type of restaurant used in the R. K. LeBlond Machine Tool Company is the dual type — one side self-service, and the other table d'hôte. The method of service is calculated to eliminate waiting, standing in line, and confusion. A list of equipment is given and should be helpful to anyone contemplating the installation of such service. The hospital department has been able to offer some constructive help on menus. — Elinor D. Gregg.

An Industrial Cafeteria, the Largest in the World. Mod. Hosp., March, 1921, 16, No. 3, 294, 296. — The cafeteria of the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa., is so well planned that 3,000 people can enter the building, eat their lunch, and leave in twenty-two minutes. It has every possible modern convenience and equipment, and is attractive both from within and without. This cafeteria was built not from philanthropic motives, but from strictly business considerations, and, run on that basis, has proved an immense success. — M. Dent.

The Factory Restaurant as a Service Nucleus. *Sanford DeHart.* Indust. Management, May 1, 1921, 61, No. 9, 338–340. — The industrial manager has long been cognizant of the ill effects of the indigestible, old time "free lunch" and the poorly balanced diet of the dinner pail. How the industrial restaurant may be made to do service from the efficiency angle is here demonstrated by a description of the restaurant in the LeBlond Plant. While the restaurant is primarily used for dining, it will be seen that for recreational purposes such as motion pictures, dances, parties, lectures, plant inspection, etc., it performs a function no less vital to the general welfare of the workers. — L. A. Shaw.

## INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Review of Labor Legislation of 1919. *Lindley D. Clark.* U. S. Bur. Labor Statis., Bull. No. 277, Jan., 1921, pp. 409. — This bulletin comprises a review of the various branches of labor legislation provided for in 1919, together with the laws of different states relating to labor and enacted since January 1, 1919. — M. C. Shorley.

Seventeenth Biennial Report of the Department of Labor and Industries of the State of Minnesota, 1919 1920. Pp. 178. — This report covers industrial accidents and diseases, benefit funds, wage movements, factory inspection, the Bureau of Women and Children in Industry, public employment offices, mine inspections, labor organizations, and a division for the deaf. — M. Dent.

Tendencies of European Labour Legislation since the War. Internat. Labour Office, Studies and Reports, Series A, No. 16, Feb. 11, 1921, pp. 18. — The report announces that the cessation of hostilities was accompanied by the rapid adoption of labor laws and regulations on subjects which, in 1914, had been regarded as entirely beyond the scope of practical polities. It presents a brief résumé of the changes made in respect to the eight-hour day, joint control, right of association and collective agreements, arbitration and conciliation, unemployment, social insurance, emigration, agricultural labor, wages, married women, health and safety, and compulsory labor.

One of the most remarkable results was the success in almost all countries in obtaining a legal eight-hour day, whereas in 1914 it was considered progressive to ask, as an international standard, a ten-hour day for women and children alone. There is a tendency to give workers a share in the control of their own work and to provide for the settlement of trade disputes. There has been some regulation in regard to the minimum wage, and experimental legislative acts concerning compulsory labor.

Another tendency in recent European legislation is toward increased protection of married women in industry. The opinions on the subject are widely varied, and there is no prospect of uniformity, except in so far as the Draft Convention adopted by the Washington Conference is applicable.

The establishment of a medical service of inspection in Belgium "is a matter of importance, which may prove to be of international influence." It provides for a central office and provincial medical officers, who will co-operate with the ordinary factory inspectors, and who will pay special attention to the health of pregnant women.

Regulations have been issued in Belgium concerning the health and safety of workers in and about mines, and in Germany for compressed air work and for the manufacture of lead compounds. New regulations for certain dangerous trades have also been issued in Great Britain. G. E. Partridge.

Compensation for Industrial Disease. Nation's Health, May, 1921, 3, No. 5, 279. — Eight of the forty-six states having compensation jurisdiction provide compensation for occupational diseases. Investigation shows that the maximum cost of occupational diseases, if included in the workmen's compensation acts, would not be greater than 2 per cent. of the aggregate cost of industrial accidents. The term "occupational disease" is here classified according to the cause and nature of the injury. — L. A. Shaw.

Health Insurance. *James M. Lynch.* N. Y. State Federation of Labor, Ninth Report, Committee on Health, 1920, pp. 19. — Investigations have shown that sickness is the principal factor in from 35 to 80 per cent. of the calls on organized charity; that 30 to 50 per cent. of loans to workers by such agencies as the Morris Plan banks, are on account of sickness; that about one-fourth of all workers are so sick that they have to remain away from work for eight days or more every year; that fully one-third of those too sick to work are without medical care; that families with the lowest wages have the most sickness; that probably 50 per cent. of this sickness is due to health hazards in industry over which the workers have no control; and that one-third of those in the poor-houses have been driven there by sickness.

The following plan has been drawn up: the cost, amounting to approximately 3 per cent. of wages, is to be shared equally by employers and workers. The benefits will be administered by local mutual organizations or funds, employers and workers to have equal control over the funds. Private industrial insurance companies operating for profit will be prohibited.

Experience has shown in all instances that while distribution of cost is primarily the method, prevention is primarily the purpose of insurance and certainly its result. — Elinor D. Gregg.

Fact and Opinion as to the British National Health Insurance Act. *Ordway Tead.* Am. Labor Legis. Rev., March, 1921, 11, No. 1, 87–93. — The author stresses the point that because Americans have heard criticisms of the British National Health Insurance they should not condemn it without trial. The opinion in England is that the act has come to stay, but that there are many improvements still to be made. As a result of the act "the general level of medical treatment is probably higher than it ever was. And it certainly is further true that thousands more people see a doctor and see him weeks if not months earlier in the progress of the disease than was ever the case before there was any health insurance. It is in this sense that the preventive work is getting its best chance under the act." — M. C. Shorley.

## REHABILITATION OF DISABLED EMPLOYEES

The Nauvoo Project. The Functions of a Special School for Inactive Tuberculous Cases. *John W. Turner.* Voc. Summary, Feb., 1921, 3, No. 10, 148–149. — "At Nauvoo, Ill., . . . the Federal Board for Vocational Education is establishing a unique project, a special school for the rehabilitation of ex-service men who have been discharged from tuberculosis sanatoria as inactive cases." The function of the school may be summed up as follows: "First. It prepares the tuberculous patient for real scientific vocational guidance, and fortifies him against a breakdown, by a course in physiology, hygiene, and job opportunities.

"Second. It adjusts the training to the man during the early critical period of his convalescence out of the hospital by providing the right environment and medical supervision.

"Third. Its purpose and function have been completed when the health of the trainee has been stabilized to the point where he can carry on with a more limited medical supervision." — Elinor D. Gregg.

Occupation Therapy. *W. Gilman Thompson.* Jour. Am. Med. Assn., June 4, 1921, 76, No. 23, 1597–1598. — The author describes the purposes, achievements, and limitations of occupation therapy as applied in our large hospitals. He makes it clear that the therapy must be prescribed by the physician and surgeon with as much care as is bestowed on any branch of physiotherapy, and evidently believes that instances of ill success in the use of occupation therapy are due more to errors in practice than to defects in the underlying idea.

The article contains a brief statement regarding the work of the reconstruction hospital at One Hundredth Street and Central Park West, New York City. — C. K. Drinker.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

Volume III NOVEMBER, 1921 Number 7

## CONTENTS



## GENERAL

Industrial Hygiene: Its Rise, Progress and Opportunities. *Sir Thomas Oliver*. Brit. Med. Jour., July 23, 1921, No. 3160, 108 116. —Since the time when Parliament, about a century ago, gave attention to the children working in mines and factories in England, industrial hygiene, which may be said to have emerged out of, or to have continued, the work of parliamentary interference with the assumed rights of employers to use labor almost to the breaking point, has made great advances. Within the last few years its scope has widened; it has become of interest to all enlightened nations; it includes not only the conditions under which work is conducted, and the diseases associated with occupation, but also the physical effects of work as shown in fatigue and output; and it attacks the problem of assuring maximum of production with minimum of effort. Medical examination of all workers, and attempts to determine the susceptibility of workers to particular poisons, now advocated, indicate the growing conviction that the liability to occupational diseases, as is the case with infectious maladies, is largely individual.

Following the historical review, there is a discussion of the work of industrial medicine and hygiene in several of its typical fields: lead, phosphorus and carbon monoxide poisoning, mining, fatigue, and industrial diseases and compensation.

Health hazards in lead working commence mainly with the smelting of the ore (lead mining in England is free from the hazard of lead

poisoning), and are continued in the processes of manufacture and use of white lead. But since 1900, regulations have gradually reduced the number of cases of poisoning, and the severer forms commonly met with thirty years ago are now rarely seen. Although much work has been done in the study of lead poisoning, there is still lack of general knowledge on the subject, and there are some special problems still to be solved. The so-called lead poisoning of painters, for example, needs further investigation. There is a question whether much of it is not due to the solvents used in paint, such as turpentine, benzine, etc., rather than to the lead, and experiments with animals tend to confirm the view that the vapors of these spirituous substances are harmful.

The writer takes exception to the decision of the International Labour Conference of the League of Nations that the use of white lead should be abolished. Suggested substitutes are also likely to be harmful, and since white lead is an important commodity, and since the history of the regulation of lead poisoning and the improvement of processes show such a remarkable success, the indications are that the need is for still further investigation and still further reduction in the risks involved, and not for abolishment of the use of white lead.

"If there is one industry to which industrial hygiene has been of the greatest service, it is the manufacture of lucifer matches." Bone necrosis, as well as the constitutional condition known as phosphorism, was frequently caused by work with phosphorus, but now, except for infrequent dermatitis from contact with the sesquisulphide of phosphorus, the whole industry has become harmless.

Carbon monoxide poisoning has still some problematic points. The effects of small quantities of the poison inhaled during a long period of time are not fully understood, but probably they are the source of some minor illnesses not diagnosed. There is evidence that a certain tolerance for carbon monoxide can be established. Boys who, in their work, are exposed to the substance may pass through a period in which they are subject to respiratory disturbances and lassitude, impaired digestion and insomnia.

Mining, still a hazardous occupation, is less dangerous than it was. The rate for fatal accidents, for example, has been reduced two-thirds during the period from 1851 to 1912 — a reduction which has been effected by careful inspection of the air in particular workings before the miner descends, better signalling, improved ventilation and better supervision of the haulage.

"If there is one side issue of industrial hygiene which has recently attracted attention . . . it is the subject of fatigue," a realization of the importance of which was especially enforced upon us by the number of persons who broke down in munition work. Of recent work on the physiology of fatigue, that of Burkard, who has demonstrated the presence of a leukocytosis in the blood after exhausting work, is of especial interest. The interpretation is that when the muscles are active they produce substances which pass into the blood stream and stimulate the blood-making tissues of the medulla of bone. Overwork, by causing a continuous over-production of neutrophil cells may, then, become injurious, not only to the medullary tissue, but to the body as a whole. Further evidence of the pathological character of fatigue is offered by the type of leukocytes found.

Industrial poisons present problems of interest in connection with compensation. The amount of poison absorbed may be so small that for a long time no harmful effects appear, and then, from no other cause than perhaps some failure of elimination, the retention limit is reached and the symptoms suddenly appear. A case is cited in which fatal lead poisoning was induced by the use of potassium iodide, prescribed for aortic aneurism, in a man who had previously suffered from lead poisoning, but who for two or three years had followed an occupation in which he was not subject to the poison.

Industrial medicine has come to stay, and it goes hand in hand with welfare work. Invention and research tend to make industry more dangerous, but the same skill which creates the dangers shows itself able to provide antidotes. The sphere of industrial enterprise is ever enlarging, and herein lies the opportunity of industrial hygiene. — G. E. Partridge.

The Necessity for Greater Attention in Industry to the Maintenance of Efficiency and the Prevention of Ill-Health. *Edgar L. Collis.* Jour. State Med., Aug., 1921, 29, No. 8, 229–237. — "The State is taking steps to bring up healthy adolescents so that they may be healthy citizens and productive workers. Industry has the duty of maintaining them in health and efficiency.

"Industry must provide hygienic conditions of work in order to diminish labour turnover, to prevent ill-health, to acquire a stable personnel, to increase efficiency, and be able to pay high wages.

"Medical supervision, which may take the form of a medical department in large establishments, is a sound investment, and is the means for maintaining efficiency and preventing ill-health.

"Industrial convalescence is needed to expedite recovery and, when linked up with re-education, can reclaim many useful workers from the ranks of the unemployable." — Barnett Cohen.

The Industrial Surgeon and Individualization. *Ralph B. Bettman.* Nation's Health, July 15, 1921, 3, No. 7, 423. — This is a brief comment on the necessity for an industrial surgeon to bear continually in mind the economic condition of his patient. The surgeon "must realize that the time element is an important one, he must question every procedure to assure himself whether it could be substituted by some other method which would shorten the time of disability. As Robert Osgood most aptly put it recently, 'the importance of gaining the largest amount of function in the shortest possible time is paramount.'" — Katherine R. Drinker.

Health Work in Five Industrial Plants. *Alfred E. Shipley.* Nation's Health, July 15, 1921, 3, No. 7, 411–414. — This article contains an analysis of the industrial health records of five plants in New York City. The industries represented are: (1) felt and silk hats, and millinery; (2) straw hats, cloth caps, and hats; (3) cocoa and chocolate; (4) rubber goods; (5) paints. The figures presented concern principally the clinic services in these plants, "although some consideration is given to the subject of sickness absence. No summaries of physical examination of new and old employes, or industrial hygiene features are included."

The total number of treatments in the clinics of the five factories was 11,089, the number of new cases, both surgical and medical, being 5,738. "In each of the five plants, the average number of clinic treatments per month may be estimated as approximately one for every two employes." For the surgical cases in the five plants there was a remarkable uniformity in the proportion of re-visits as compared with the first treatment, an average of two re-visits being necessary for each surgical case. Greater proportions of medical cases occurred in the plants which employed large numbers of women.

An interesting uniformity is seen to exist in the character of the clinic cases seen in the five industries. Of the surgical cases, approximately 50 per cent. were finger cases, and from 70 to 75 per cent. conditions affecting the entire upper extremity. In reviewing the causes of accidents the author found that very few were due to lack of mechanical guards but the vast majority were "the result of carelessness, inattention, poor physical condition of the worker, or some other personal factor."

On the average, about 50 per cent. of absence was due to sickness, a large proportion being of the one and two-day type. During a period of decreasing demand for workers, there was less sickness absence, showing that employees are not inclined to stay at home for trivial illness when their places can be readily filled.

In conclusion, the author emphasizes the practical importance of facts such as are presented in his report. "They are not matters merely of academic research, but to those trained to interpret such readings they provide the means to administer industrial health service intelligently and effectively. Furthermore, the keen, practical factory manager appreciates facts which show him the health status of the human power under his direction, and enable him to compare conditions in his own plant with those in other industries." — Katherine R. Drinker.

Occupational Diseases in Chemical Industries. How the Workers in Chemical Plants are Safeguarded. *Frederic Dannerth.* Indust. Management, Sept. 1, 1921, 62, No. 3, 145–147. — In this article the author tells how the danger to the lives of workers in industries in which white lead paint, wood alcohol, and carbon tetrachloride are used, and in industries in which dusts are present, may be reduced to a minimum. — M. C. Shorley.

The Porcelain and Earthenware Industries from the Standpoint of the Protection of the Workers and the Neighborhood, and Measures for Fighting the Danger.

*Thieme.* Zentralbl. f. Gewerbehyg., May, 1921, 9, No. 5, 89-94. — The sources of dust from the earthen materials and of lead from the glazes are discussed. The use of adequate ventilation, frequent cleaning of the workrooms, personal cleanliness, and improved mechanical aids to replace hand work are described. Tuberculosis is frequent among these workers, presumably due to the excessive dust. Lead poisoning is relatively rare. The only injury to the neighborhood is from the excessive smoking of the ovens. This may be done away with by the use of producer gas for heating. — E. L. Sevringhaus.

Some Medical Impressions of the Miners' Strike. Brit. Med. Jour., July 16, 1921, No. 3159, 94. — The writer, who is a practitioner of twenty years' experience in a mining district, records a remarkable improvement in the general health of miners during a strike, when they lived an easy life and engaged in sports. The number of cases of sickness was greatly reduced, and the appearance of the men and their ability to recuperate from illness were improved. The question is raised whether it would not be profitable, both economically and morally, to give the collier fourteen days of rest from work, with full pay, after every three months of full-time work.

There might be established also, in every large colliery, a miners' welfare committee composed of medical men. The work of this committee would be to collect statistics and study the hazards of mining as well as the personal hygiene of the miner. "If one-half the energy expended during the war . . . to keep the soldier fit and well could now be devoted to improving the physical (and consequently the moral) well-being of men engaged in uncongenial industries, we should make much progress in the direction of increasing the efficiency and output in these industries."

In regard to the field of industrial medicine, Linenthal is quoted approvingly: "Industrial medicine in its wider meaning is a field primarily not for the industrial physician but for the physician in the general practice of medicine who must recognize that states of ill health are in many instances due to the hazards of industry." — G. E. Partridge.

X-ray and Radium Protection. Brit. Med. Jour., June 25, 1921, No. 3156, 936–937. — This is a report of a committee representing various scientific bodies having headquarters in London.

The effects upon the operator, which are to be guarded against, so far as are known, are: visible injuries to the superficial tissues, derangements of internal organs, and changes in the blood. As a general preventive plan, it is urged that there be not more than seven working hours each day, with Sundays and two half-days free each week, and a month of vacation yearly.

A first precaution in all X-ray work is to surround the X-ray bulb as completely as possible with protective material. Directions are given for protection in each of the operations in use: work with X-rays for diagnostic purposes; for superficial therapy; for deep therapy; for industrial and research purposes; and radium therapy. Ventilation of X-ray departments and "electrical precautions" are also treated.

Recommendations for each branch of the work are too numerous and too explicit to be presented in a summary, and the report should be read by anyone interested in the subject.

As a general measure it is recommended that, wherever possible, periodic tests — every three months, perhaps — should be made upon the blood of those who work with X-ray apparatus, etc., and are exposed to the risks under discussion, so that changes may be recognized at an early stage. — G. E. Partridge.

## SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

### MENTAL

Mental Hygiene in Industry. *C. Macfie Campbell.* Ment. Hyg., July, 1921, 5, No. 3, 468-478. — "The mental health of the industrial worker depends upon the complicated interplay of the individual personality, the specific conditions of the industrial task, the economic factor, the domestic and general social environment.

"When dealing with the disorders of the individual worker and of groups of workers, it is

not always possible to isolate single symptoms and supply specific remedies, medical or social; and one must be prepared to make a very detailed analysis, and the remedies may be of slow evolution.

"So far there is not available enough well studied material for useful constructive suggestions to be made; to gather such material is a task of immediate importance.

"The development of an enlightened public opinion on these topics would be a most important contribution to the mental health of the community and to social and economic stability.

"The attention paid during war time to the mental health and morale of those engaged in the business of destruction is no less necessary during peace time for purposes of construction; mental health and good morale are as important in peace as in war, and to muddle along in peace may be as disastrous as to do so in war." — Stanley Cobb.

### RESPIRATORY SYSTEM

The Pneumokonioses. Internat. Jour. Pub. Health, July Aug., 1921, 2, No. 4, 401 408. This article is a review of recent important contributions to the already extensive bibliography of industrial tuberculosis, dealing principally with the pneumokonioses.

"In all industries under consideration want of proper attention to the welfare of the worker is more in evidence than a lack of positive knowledge concerning the aetiology and method of transmission of the diseases.

"Modern preventive medicine requires medical examination and X-ray control, not as a luxury but as an absolute necessity. A clinical examination should also be compulsory for all candidates wishing to enter a dangerous trade, subsequent periodical medical examinations being the obvious complement of this first examination. Adults suffering from pneumokoniosis after many years of work should be able to change their trade and should receive indemnity. Working conditions must be controlled and the quantity of dust in the atmosphere breathed should be regulated by a standard of enumeration rather than one of weight per volume. The exact statistics of tuberculosis morbidity and mortality should be brought into relation with the scientific evaluation of dust in the atmosphere. Finally, in the intervals of work opportunities should be afforded for healthy open-air recreation.

"The medical profession may well feel the obligation to prepare public opinion for stricter legislation in this direction in order that the tuberculosis morbidity of adults threatened with pneumokoniosis may be reduced, if not to the normal rate, at least to something less terrible than its present high level." M. C. Shorley.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Memorandum on Lead Poisoning. Internat. Labour Rev., May June, 1921, 2, Nos. 2–3, 231 233. This is a summary of a memorandum on industrial lead poisoning issued by the British Home Office.

Figures for the past twenty years show a marked reduction in the number of cases of lead poisoning, except in the electric accumulator industry; and the present memorandum shows also decrease in the severity and in the proportion of chronic cases.

Two-fifths of all reported cases occur during the first eighteen months of work, and the symptoms mentioned as most frequent in the Annual Report of the Chief Inspector of Factories are: gastric troubles, anemia, headache, paralysis, encephalopathy, and rheumatism. Paralysis is more common in men than in women but the contrary is true of encephalopathy.

The number of deaths recorded during the twenty years has not diminished in proportion to the number of cases, because after the Workmen's Compensation Act of 1906, lead poisoning is more often mentioned as associated cause on the death certificates of lead workers suffering from chronic nephritis and its sequelae. The attack rate per thousand is given for ten industries. Electric accumulators lead with 27; white lead shows 26; tinning of metals 20; paints and colors 16; vitreous enameling 14; smelting of metals 13.

The memorandum contains also information about processes in which lead poisoning is fre-

quent, symptoms and diagnosis, and preventive measures that have been taken. — G. E. Partridge.

The Contrast between the Brain Lesions Produced by Lead and Other Inorganic Poisons and Those Caused by Epidemic Encephalitis. *G. B. Hassin.* Arch. Neurol. and Psychiat., Sept., 1921, 6, No. 3, 268–285. — The author draws the following conclusions:

"1. The nonsuppurative inflammations of the brain may be divided into two large groups. One, represented by epidemic encephalitis and paralytic dementia, is of infectious origin. Pathologically, it is characterized by excessive, widespread perivascular, and sometimes also parenchymatous, infiltrations, the pia-arachnoid changes being quite mild. This type may also be defined as an infiltrative encephalitis which thus includes all possible direct infections of the brain tissue proper.

"2. The second group, mainly represented by lead encephalitis, is due to intoxication and should, therefore, be termed toxic. Pathologically, it shows a great preponderance of proliferative or (as Bonfiglio puts it) 'productive' phenomena in the mesodermic tissues (blood vessels, capillaries and the pia-arachnoid). This group may be termed productive encephalitis.

"3. Microscopically, it is not only possible to determine whether any given case is one of a nonsuppurative encephalitis, but also whether the encephalitis is due to an infection or to an intoxication.

"4. The study of the pia-arachnoid and the subarachnoid space is of paramount importance in determining whether the brain is normal or pathologic, for these structures may exhibit changes even when the brain tissues proper appear normal." — M. Dent.

Some of the Effects of Chronic Lead Poisoning, with Special Reference to Arteriosclerosis. *G. B. Page.* Jour. State Med., June, 1921, 29, No. 6, 161–168. — It is suggested that an insidious result of mild, chronic lead poisoning is arteriosclerosis. The lead damages the renal parenchyma, which in turn causes an increased arterial pressure. Measurements on painters show a higher blood pressure than those on non-lead workers. — Barnett Cohen.

Chronic Arsenic Poisoning. *R. Stockman.* Abstracted as follows from Edinburgh Med. Jour., July, 1921, 27, No. 1, 1, in Jour. Am. Med. Assn., Sept. 3, 1921, 77, No. 10, 816. — "Stockman claims that the administration of arsenic compounds may be safely continued for a considerable period after pigmentation of the skin and keratosis have developed. If slight, these clear off rapidly after the administration is stopped, and seem to leave no ill effects. Very deep pigmentation may be permanent, and in a few cases the development of cancer has been noted, apparently following on local irritation. On the other hand, its administration should be stopped at once as soon as the slightest signs of neuritis appear. The lesion is always tedious and troublesome to get rid of, and in some cases is permanent." — C. K. Drinker.

Tar Sarcoma in Rabbit. *K. Yamagiwa, S. Suzuki,* and *K. Murayama.* Abstracted as follows from Mitteil. a. d. Med. Fak. Univ., Dec. 28, 1920, 25, No. 2, 189, in Jour. Am. Med. Assn., Sept. 3, 1921, 77, No. 10, 823. — "The fibromyxosarcomatous tumor developed in the mamma of a rabbit twenty-three months after the beginning of the course of thirty-one injections of tar in the mamma. A recurrence developed with metastases after excision of the tumor, and scraps of it proliferated when injected in other rabbits. This was the only positive cancer produced among the 200 rabbits in the tests. (In German.)" — C. K. Drinker.

Medical Opinions on Industrial Poisonings. *F. Curschmann.* Zentralbl. f. Gewerbehyg., April, 1921, 9, No. 4, 73–81. — *VI. Death Following Employment with Trinitrotoluol Caused by Poisoning or by a Pre-Existing Liver Disease?* — A man who had worked for some months in contact with trinitrotoluol came down suddenly with a general jaundice and enlarged painful liver; after increasing mental cloudiness and the appearance of albumin and tyrosin in the urine he died. Postmortem examination revealed what seemed a cirrhosis of the liver. It is here given as the opinion that this was not cirrhosis plus an acute poisoning, but a cumulative liver damage with a sudden ending, due to nitrated hydrocarbons.

*VII. Death as a Sequel to Respiration of Trichlorethylene.* — A 48-year old shoemaker was accidentally exposed to considerable amounts of trichlorethylene. After two days

he recovered from the stupor and weakness, and was again at work. He continued to suffer head pains and dizziness and became progressively more anemic and weak. He is known to have been undernourished. Five months later he became ill with what was supposed to be influenza, and a month later died. When claims for compensation were made the body was exhumed, and an extensive brain abscess coming from an old tuberculous otitis was shown to be the cause of death. The various possibilities that the trichlorethylene poisoning may have been a contributory cause of death are discussed. The question cannot be settled with certainty, but it is probable that a small part, if any, was played by the gas.

*VIII. Degeneration of the Liver Following Dinitrobenzene Poisoning.*—An 18-year old girl began to have jaundice after exposure to dinitrobenzene during two and a half months' work at filling shells. Following a sickness of nearly two months, with enlarged liver, abdominal pain, and jaundice, she died with a severe hemorrhage from the mouth and nose. The case is very probably one of acute diffuse hepatitis with fatty degeneration of the liver, so frequently due to nitro-compounds.—E. L. Sevringhaus.

Benzene Poisoning in Rubber Manufacturing. *Robert S. Quinby.* Abstracted as follows from Rubber Age, 1921, Vol. 8, 451, in Chem. Abstr., May 10, 1921, 15, No. 9, 1422. —"A review of the bulletin of the Rubber Association of America on the use of benzene."

Studies in Carbon Monoxide Asphyxia. I. The Behavior of the Heart. *Howard W. Haggard.* Am. Jour. Physiol., July 1, 1921, 56, No. 3, 390-403.—"Death under carbon monoxide asphyxia is due to failure of respiration. This is in the nature of a fatal apnoea vera. The anoxemia resulting from the formation of carboxyhemoglobin induces excessive breathing; and respiratory failure follows the excessive loss of $CO_2$.

"Oxygen deficiency caused by carbon monoxide, even in advanced asphyxia, is not in itself sufficient to cause impairment of auriculoventricular conduction. Following respiratory failure, however, the increased anoxemia from this cause speedily results in the development of heart block through its various stages.

"By restoring respiration and rapidly eliminating the carbon monoxide by means of inhalations of carbon dioxide and oxygen, cardiac conduction is restored to normal following the development of block.

"The cardio-inhibitory center maintains its activity longer than does the respiratory center. This center is stimulated by the increased $C_H$ which occurs during respiratory failure. From this there results a temporary cessation of auricular activity. This period of inhibition is prevented by the administration of atropine.

"When respiratory failure is prevented by means of inhalations of 8 or 10 per cent. carbon dioxide, the carbon monoxide combination with hemoglobin rises to an unusually high percentage without any evidence of impairment in a-v conduction. This indicates that there is no direct toxic action of carbon monoxide upon the cardiac conducting system.

"Illuminating gas results in an earlier development of respiratory failure than does pure carbon monoxide in corresponding concentration.

"Electrocardiographic records are given from two animals which differed from the rest in that one developed a transient period of alternation involving the R and T waves and the other presented, during the time of complete a-v block, a condition resembling auricular fibrillation or flutter."—C. K. Drinker.

On Carbon Monoxide Poisoning in a Foundry. *O. Gros* and *M. Kochman.* Abstracted as follows from Vrtljschr. f. gerichtl. Med., 1921, 61, No. 1, in München. med. Wchnschr., May 6, 1921, 68, No. 18, 559.—"This article contains the opinions of medical experts on the question whether the death of a worker who was suddenly taken ill in a foundry and died two days later, and in whose blood carbon monoxide was detected at autopsy, should be considered as an industrial accident. The question was answered in the affirmative."—M. C. Shorley.

Dangers to Health in Autogenous Welding. *Jenny Adler-Herzmark.* Zentralbl. f. Gewerbehyg., May, 1921, 9, No. 5, 97-98.—The author investigated a number of small industries where autogenous welding is done and found that acute attacks resembling brass founder's ague, and probably identical with it, are always associated with the use of hot brass or zinc. Zinc vapors were often visible. Either zinc or zinc oxide is the causative agent of the

disease. It is proposed to determine experimentally whether the corrosive action of zinc oxide is so extensive that after a few hours the absorption of the damaged tissue may cause a fever. Is the more severe gastric part of the attack to be associated with zinc chloride formed in the stomach? — E. L. Sevringhaus.

Sickness and Death Due to Ferrosilicon. *Thiele.* Zentralbl. f. Gewerbehyg., May, 1921, 9, No. 5, 94–97. — The death of three individuals in one house following a brief illness marked by head and body pains, vomiting and stupor, and the similar illness of several other occupants of the house were at first diagnosed as due to grippe, and later, to food poisoning. It was finally found that the occupants of the house had been poisoned by gas. On the ground floor was stored a large amount of ferrosilicon which had been wet by rain just before being brought in. Due to impurities in this commercial ferrosilicon, phosphine was evolved and caused the poisoning. Arsine, hydrogen sulphide, and acetylene were other possible contaminating substances, but none of these could be demonstrated as obtained from the ferrosilicon. The possibility of such gases being formed from ferrosilicon has been demonstrated before, several instances of which are cited. — E. L. Sevringhaus.

## DUST HAZARDS AND THEIR EFFECTS

Investigation of Dust in the Air of Granite-Working Plants. *S. H. Katz.* Abstracted as follows from U. S. Bur. Mines, Reports of Investigations, No. 2213, 1921, pp. 2, in Chem. Abstr., May 10, 1921, 15, No. 9, 1368. — "In the pulmonary disease, designated as granite pneumonoconiosis, to which granite cutters are subject, it is estimated that particles of the hard insoluble rock-forming materials about 1 micron in diameter are most injurious. Smaller particles either do not readily lodge or are more easily eliminated. In an investigation of this disease at Barre, Vermont, the principal granite-producing town of America, the dustiness of the air was determined by 3 methods. Two of these methods involved the catching upon a sticky glass plate the dust particles from a volume of air impinged at high velocity on the plate by a small air pump, the particles caught being counted by the aid of a powerful microscope. In the other method the air was filtered through a layer of granulated sugar, the sugar dissolved in $H_2O$, a portion examined microscopically to count the stone particles, then the whole sample filtered, the filter paper ignited and the dust weighed. The dustiness is expressed in millions of particles per cubic foot and on a weight basis in mg. per cubic foot."

How to Catch and Ship Dust. *M. R. Radford.* Factory, July, 1921, 27, No. 1, 68. — "The powder which constitutes the remarkable product of this company is stored in a large storehouse from which a covered conveyor brings the material along under the ceiling of the packing room and feeds it into packing machines, which mechanically fill paper cartons with the correct quantities. Where the nozzle of the machine delivers the powder into the cartons the process naturally breaks some of the grains into fine dust, which used to escape and cloud the room. An air exhaust now piped to the delivery nozzle of each machine draws away this dust before it can scatter.

"Each air pipe connects to a large exhaust pipe which is suspended from the ceiling. This pipe passes out through the wall of the building onto the top of the adjoining storehouse. On the top of the storehouse are two cyclones or extractors and settling boxes. The air pipe delivers the dust to the first extractor; it whirls around inside and most of it settles to the bottom, drops through the hole in the roof of the storehouse, and falls upon the pile of material beneath. Some of the dust reaches the second extractor, where it settles and drops through to the storehouse. Thus all the dust is not only kept out of the workroom, but is recovered and is used again." — M. Dent.

Coal-Dust Hazards in Industrial Plants. *L. D. Tracy.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2242, April, 1921, pp. 6. — Since the use of pulverized coal as fuel in heating furnaces in steel mills was introduced, fires and explosions have occurred. The Bureau of Mines, therefore, investigated the conditions, and found that there was a lack of knowledge of the explosive character of coal dust. The first requirement, consequently, is that in all plants

where pulverized coal is used for fuel, the men should be taught that clouds of fine coal dust are as dangerous as a body of unconfined natural gas.

Experiments in the mine of the Bureau of Mines have shown that pressures as high as 130 pounds per square inch may be produced in coal dust explosions, and experiments have also demonstrated that a mixture of 30 per cent. of pulverized coal dust and 70 per cent. of finely powdered shale is explosive. Analyses of dust from the interiors of buildings where pulverized coal is used shows that the dust sometimes contains as high as 23½ per cent. of volatile matter.

There is danger also of spontaneous combustion of pulverized coal in the bins, and studies have been made to determine the conditions affecting oxidation in which it was found that oxidation is accelerated with rise of temperature. If enough air is present, pulverized coal, when delivered at a storage bin at a fairly high temperature, will in a short time approach the point of ignition. As a matter of fact, owing to dryers becoming overheated, the coal is likely to be delivered at a temperature making combustion probable. It is especially likely to happen in the type of dryer known as the "direct heat" dryer. Storage bins for pulverized coal should not be placed where they may become heated from furnaces, steam pipes or hot flues. If a plant has been shut down for a few days, coal should not be delivered through transport lines until it is known whether the coal has become heated.

Some of the fires in the distribution lines have originated as back fires from the heating furnaces, caused by sudden changes in the air pressure, which may take place in several ways. So it is important that no chance be given for burning particles to enter into the transport line, and the line should be cleaned frequently by allowing the fan to force a current of air through it.

When furnaces have individual fuel bins and the coal is delivered into the primary air line by means of screw conveyors, the fuel bins should be placed away from the furnaces; otherwise fatal accidents, as frequently happens, may occur by dust overflowing the line and falling down before the furnace door.

As regards the pulverizing plant, every precaution must be taken to prevent accumulation of dust. No system of ventilation can be relied upon, when there is a hazard from coal dust, but the vacuum cleaner has been found a practicable means of keeping the interiors of buildings clean. In examining storage bins, etc., electric light and not an open light should be used, the electric bulb should be protected by a wire guard, and the wire must be properly insulated. G. E. Partridge.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

The Treatment of Cutaneous Anthrax. *W. H. Ogilvie* and *A. W. Hall*. Brit. Med. Jour., June 18, 1921, No. 3155, 889–890. — The authors quote from Circular 172, issued by the Ministry of Health, Jan. 28, 1921, figures with regard to the results of various forms of treatment in 800 cases of cutaneous anthrax which, according to the circular, support the conclusion that excision is unnecessary, and compare with these figures records from Guy's Hospital, which show that when both excision and serum are used the death rate is notably lower than when either treatment is used alone. From their experience at Guy's Hospital they conclude that:

"Excision by itself will assure a cure in about 90 per cent. of cases in a disease having a natural mortality of something like 50 per cent., while serum at best cannot be relied upon to avoid a fatal issue in all cases. In view of the danger of anthrax and the local nature of the infection in the early stages, it therefore appears to us to be the wiser course to combine the two methods, which are both known to be good and which cannot be mutually antagonistic, and thus to give the patient every chance. Little or no importance can in the circumstances be attached to the resulting scar. We consider, then, that the combination of excision and serum treatment as used at Guy's Hospital is probably the most rational and the safest course in all cases of cutaneous anthrax which have not reached the stage of a septicaemia." — M. C. Shorley.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Injuries to the Eye with Report of 1051 Cases. *Don M. Campbell* and *John M. Carter.* Am. Jour. Ophth., May, 1921, 4, Series 3, No. 5, 336–344. — "This is an analytic account of the cases seen in a period of two years, giving the kind of history obtained, the clinical data brought out in the two classes of cases, minor injuries and major. The diagnosis including the importance of the history and the use of the X-rays is discussed. The removal of foreign bodies from inside of the eye is considered with results from twenty-four magnet extractions. The importance of early diagnosis and treatment is insisted upon."

To summarize the points of interest and practical importance:

"1. In this series we have two great classes of work responsible for most of our cases, namely, emery grinding and steel or metal work, the two totaling 81.3 per cent. of all the injuries.

"2. That by far the greatest number of our major injuries occur in the second group, i. e., those working on metals.

"3. Taking the series as a whole, about one case in every thirteen, or 7.9 per cent. were major injuries, while in the cases occurring in the steel group one out of every eight cases, or 12.9 per cent., were major injuries, the percentage being much higher in the steel group.

"4. That better than one in ten of all our cases have required an X-ray, before we could be positive that a foreign body was not inside the eye.

"5. 117 X-rays were taken, and 100 of these occurred in the steel group.

"6. 20, or 17 per cent. of the radiograms taken were positive for foreign body inside of the eye, and all these occurred in the steel group.

"7. The danger signal is that 71 per cent. of our major injuries occurred in the steel group, all our positive X-rays occurred here, and 60 per cent. of the eyes lost, or blind, were chargeable to metals. Such figures should cause us to adopt the attitude that all cases injured while working on metals are serious, and to treat them as such.

"8. The magnet operation, as such, can be considered quite successful; we were able to remove the magnetizable foreign body in 95 per cent. of the cases.

"9. 23.8 per cent. of the cases on which we did an iridectomy had a normal vision following the operation.

"10. 68.5 per cent. of the cases were seen at our office on the day they were injured, 43.5 per cent. on the second day after their injury, 17.5 per cent. on the third day, while better than 1/5 of the cases, or 21.5 per cent. waited four days or longer, before they applied at the office for treatment. These last figures, we believe, are very important. Delay in the making of a correct diagnosis, and delay in the instituting of proper treatment are two of the most potent factors responsible for permanent injury to the eye, and are responsible for not a few of the artificial eyes that we see.

"If the results here reported are to be classed as a meritorious showing, certainly the credit is to be shared with those surgeons and general practitioners who early in their cases have realized the necessity for special examination or treatment. If the number of eyes enucleated or permanently impaired is to be materially lessened, then we must strive to obtain a higher grade of ophthalmic judgment, not only in the oculist but also in the general medical profession. The delay in correct diagnosis and proper treatment must approach a minimum." — M. C. Shorley.

Cataract in Iron Workers. Abstracted as follows from Brit. Jour. Ophth., May, 1921, in Brit. Med. Jour., June 18, 1921, No. 3155, 905. — "The fact that cataract is peculiarly liable to develop in glass-workers is well known, and much information on the subject has been published from time to time in our columns. Evidence is now advanced that iron workers are also unduly liable to cataract. Three papers on the subject are published in the *British Journal of Ophthalmology* for May, 1921. Cridland, of Wolverhampton, deals with cataract in puddlers, among whom the cases are comparatively few. He points out that the number of puddlers is by no means large, and is likely to decrease in the future, as steel replaces puddled iron. His contribution adds a few details to the well-known paper which he published on this subject in 1915. St. Clair Roberts has collected notes on cases of cataract occurring in chainmakers at Dudley. In all he found a posterior

polar and cortical opacity very similar to that described in glass-blowers. In describing the method of chainmaking by hand, he states that machines for making chains have not proved successful, and he tells us that it is a common belief among the workers that the sight should fail between the ages of 50 and 60. In uncomplicated cases there is no associated lesion of the fundus, and the results of operation are good. The most comprehensive of the three papers is that by Healy of Llanelly, who, having previously had experience of bottle-makers' cataract in Sunderland, has produced really valuable statistics of the number of cataract cases occurring in men of 35 years of age and over engaged in the tinplate industry at Llanelly. He also describes the nature of the work at length, and gives details of 209 cases. In his cases the *posterior* cortical type of opacity often existed in combination with cortical striae. His paper strongly confirms the supposition that it is the infra-red heat rays which are the important ones in the etiology of this condition, for in the tinplate mill the men are not exposed to ultra-violet rays. The atmosphere of the mills is dusty, and the men perspire freely; they are adverse to the wearing of protective goggles, but Healy believes that much might be done by suitable propaganda to overcome this prejudice. This series of papers offers weighty evidence in favor of the suggestion that cataract in iron workers should be scheduled under the Workmen's Compensation Act, as well as glass-makers' cataract. The Glass-Workers' Cataract Committee of the Royal Society has sent a deputation to Llanelly to inquire into Dr. Healy's cases, and there is reason to hope that the Home Office will shortly place these trades upon the schedule. These papers appear to us to be amongst the most important contributions to ophthalmology that have recently been published." — M. C. Shorley.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Discussion of an American Accident Table. *Carl Hookstadt.* U. S. Bur. Labor Statis., Month. Labor Rev., July, 1921, 13, No. 1, 1–5. — The writer compares the accuracy of the recently published American table with the standard accident table completed by Dr. I. M. Robinson six years ago. — R. B. Crain.

Fatal Industrial Accidents in Canada Increase during 1920. Nat. Safety News, July, 1921, 4, No. 1, 28. — "There were 1,170 fatal industrial accidents in Canada during 1920 as compared with 1,068 in 1919." These statistics are from the Canada Labour Gazette, and are admittedly incomplete. — M. Dent.

Explosion of Gas Tanks. *Helwig.* Zentralbl. f. Gewerbehyg., April, 1921, 9, No. 4, 84–85. — The explosion of two oxygen tanks in a locomotive shop is explained as probably due to one tank having fallen on the other. The tanks were not connected with a burner. Other oxygen tanks in the lot were found not to contain explosive gases mixed in the oxygen. Several other cases of steel gas tanks exploding without combustion are cited. — E. L. Sevringhaus.

Where a Hell-Hole Might Have Been. *Louis Resnick.* Nat. Safety News, July, 1921, 4, No. 1, 5–9. — The mining town of yesterday is described with its dirt, desolation and drunkenness, and is compared with a model mining town of today in which the greatest accident problems in the world — those of coal mining — are being solved. The hazards peculiar to coal mining are described in detail and the following are given as some of the safety improvements made by this company — the Inland Collieries Company of Indianola. The brattices are made of stone; the trolley wire at particularly dangerous spots is protected by a wooden channel; accidents at switches, curves, and doorways are avoided by the installation of a single incandescent light at every switch, door, and curve; a block signal system is used which practically eliminates the possibilities of head-on or rear-end collisions of trains; and ventilation is carefully inspected.

But the safety engineers of this company find that the most effective precaution is eternal vigilance and a ceaseless propaganda for safety given in the weekly first-aid and safety meeting for workmen. — M. Dent.

Remarkable Record Made in Building Concrete Ships. *L. D. Woedtke.* Nat. Safety News, June, 1921, 3, No. 16, 25–26. — This is a report of successful accident prevention in construction work, which, the writer asserts, is un-

usually hazardous. During a full year there were no fatal accidents or serious permanent injuries. The average number of employees was 506, and for a total of 1,518,334 hours worked, the whole number of accidents causing time lost for more than the day or shift was seventy-four. There were in all twenty-nine compensation cases. The success is attributed to effective co-operation on the part of all concerned, and good service rendered by insurance underwriters. — G. E. Partridge.

1,100 Steel Workers Make 60 Days No Accident Record. Nat. Safety News, June, 1921, 3, No. 16, 31. — This is a report from the American Works of the American Steel and Wire Company at Cleveland, Ohio. Employees of the carpenter and pattern shop of the Rankin Works of the same company have made a record of 1,271 days without an accident. Other departments have also made good records, and the result is attributed to interplant and inter-department competition. — G. E. Partridge.

Preventing Accidents on Power Transmission Machinery. *W. D. Keefer.* Nat. Safety News, June, 1921, 3, No. 16, 17–18. — There are two main ways of eliminating accidents from transmission machinery: eliminating, wherever possible, the transmission machinery itself; and supplying proper guards. Another means is the prohibition of all work on such machinery when it is in motion.

Rules for installing guards for shafts and belts, and directions for eliminating various hazards are given. There is a diagram showing details of a standard belt guard, and the following general principles are laid down:

The guard should be so designed that it will prevent all accidents.

The guarded part must be easily accessible for oiling, inspection and repairs.

The guard should not interfere with production, nor with cleaning about the machinery.

The guard must be strong enough to resist injury and to hold its shape (metal guards are preferable).

A committee of men representing all interested parties has been organized under the auspices of the American Engineering Standards Committee to draft a Safety Code on Power Transmission Machinery. — G. E. Partridge.

Safety Requirements of Woodworking Shops. *W. Dean Keefer.* Nat. Safety News, July, 1921, 4, No. 1, 23–25. — The essential consideration for safety is in the arrangement of the machines in regard to space for the workmen to move around in, light, height, vibration, and the nearness of the starting and stopping devices. Guards are described for circular saws, rip and railroad saws, band saws, jointers and planers, shapers, etc. — M. Dent.

Circular Saws — Keep Them Sharp, Safe, and Efficient. *E. Ross Farra.* Nat. Safety News, July, 1921, 4, No. 1, 15–17. — "A reduction of 75 per cent. in circular saw accidents can be made merely by keeping them in good condition. . . . A saw that is not in good condition requires greater power from the driving motor or steam engine, it does not saw a clean, straight cut in the wood stock, it causes the wood to bind on the saw and kick back, and it requires more effort on the part of the saw operator to push the wood through the machine, thereby increasing the danger of his slipping or losing his balance or running his hand into contact with the saw blade." Details are given as to ways of keeping saws in good condition. — M. Dent.

Two New Protective Devices from the Amsterdam Safety Museum. *Scholte.* Zentralbl. f. Gewerbehyg., May, 1921, 9, No. 5, 101–102. — Scholte's short paper describes and diagrams in a purely technical manner a new device for preventing the hand of a printer from being crushed in a printing press. The first of these devices (for shafts on lathes and polishing machines) was described in This Journal, Feb., 1921, 2, No. 10, 201. — E. L. Sevringhaus.

Strength of Hoisting Cables Needs More Attention. Nat. Safety News, July, 1921, 4, No. 1, 22. — "The necessity of giving greater attention to a margin of safety in respect to the strength of cables and chains used in hoisting heavy building and other materials is emphasized by a recent accident in New York City, in which twelve tons of steel beams fell from the tenth story of a skyscraper under construction." — M. Dent.

How to Make Floors in the Plant Safe. Nat. Safety News, June, 1921, 3, No. 16, 19–20.

— During the year 1919, nearly 12,000 people were killed by falling, and a very large part of these accidents can be traced to bad floors. The floor should be strong enough to bear at least four times the standing load that is to be placed upon it, and six times the moving load to which it may be subjected; and it should be free from projections, depressions and splinters, and be as nearly noiseless as possible. A good wooden floor consists of narrow hardwood material, matched and nailed on a wooden underfloor; but at best, wooden floors require much attention. Concrete floors are growing in favor; they are easily made, are safe as regards slipping, and are especially good when flushing is necessary. Wooden blocks also make a good floor material. Brick floors, laid with paving bricks, and granite block floors are suitable for many purposes.

A good way of overcoming the slipping hazard on oil-soaked floors is to apply powdered rosin, or to apply to the floors about the machines a heavy coat of thick, hot, wood flake glue and sprinkle fine sand over it before it cools.

Cleanliness is important. One method of cleaning greasy floors is to sprinkle air-slaked lime over the floor so as to cover it for a depth of about 1/4 inch. This is left for two or three hours and then removed with a stiff brush. This method has been used successfully on oily cement floors that have resisted all other cleaning processes.

Suggestions are made in regard to guarding floor openings, protection from fire and heat, etc. — G. E. Partridge.

How to Prevent Burns. Nat. Safety News, June, 1921, 3, No. 16, 29. — This is a discussion by several writers. The hazard from the handling of acids in cleaning metal to be plated has been eliminated by one company by the substitution of the sand-blast. A tapping hole shield (consisting principally of chains lowered in front of the tapping hole) has been found by another company to be most effective in preventing burns from molten metal. Similar shields are used in other processes. Proper attention to the condition of the hose and hose connections is said to help in preventing steam and hot water burns. Another concern reports a great reduction in the number of burns as a result of requiring every man to wear proper protecting devices. One safety engineer expresses the opinion that the main solution lies in education. — G. E. Partridge.

More Tips on Preventing Burns. *Almon P. Young.* Nat. Safety News, July 4, 1921, 4, No. 1, 18. — The following points come from the General Electric Company at Fort Wayne: "We instruct the new men on real dangers in handling tests, we supply special insulated disappearing-tip contractors hung on standards and counterweighted for circuit testing. We use special rubber insulated grips for temporary connections in testing departments. We have remote control on high tension lines, all lines being run in conduits. We have special fuse pulling devices, sheet metal boxes around starting rheostats, guard rails and fences around switch boards, test departments fenced off, and high tension lines and terminals all marked with danger signs. We use screens around arc welders to prevent burns from radiation, and danger signs posted, and we supply welders with protective equipment. We have instructed plumbers and steam fitters on shutting off steam before repairing high pressure lines. We have posted instructions for operating gas burners and ovens. We have supplied special equipment for handling hot materials and special gloves or brakes for breaking revolving test spindles and shafts." — M. Dent.

Etiology and Prevention of Injuries to the Eye. *Harry V. Würdemann.* Mil. Surgeon, Aug., 1921, 49, No. 2, 176–187. — The author describes briefly the commonest types and causes of eye injuries, and emphasizes the importance of protective apparatus. Safety appliances are in use in most dangerous trades, and, according to the twelfth census, have markedly decreased the proportion of accidents within the last ten years. Laws compelling such devices, with compensation and insurance laws, have been enacted in thirty-one states. There is, however, much opposition among the workmen to the use of these appliances, and constant supervision is necessary.

The procedure in the diagnosis of eye injuries is described rather fully, and suggestions are given for the detection of malingering in the examination of an injured person from a medico-legal standpoint. — M. C. Shorley.

## INDUSTRIAL SURGERY

Flat Foot as a Problem of Industrial Surgery. *R. B. Bettman.* Nation's Health, Aug. 15, 1921, 3, No. 8, 461–462. — Flat foot occurs frequently in workers obliged to stand for long hours or to walk continually on hard floors. It is a disease of the new employee, of the worker transferring from a sedentary job to one requiring standing or walking, and of the convalescent from a recent illness.

The symptomatology of weak foot is described. Dr. Bettman suggests as corrective measures change of employment when the condition is the result of occupation, improvement of the patient's general physical condition, correct shoes, adhesive strapping or exercises. Arch supports are said to afford great relief in many instances and under such conditions it is believed that patients should be allowed to wear them. — Wade Wright.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

On the Estimation of the Physiological Cost of Muscular Work: The Significance of the Respiratory Quotient in Indirect Calorimetry. *J. B. Orr* and *J. P. Kinloch.* Brit. Med. Jour., July 9, 1921, No. 3158, 39–40. — Waller and De Decker have described a rapid method for estimating the cost of muscular work based upon $CO_2$ exhalation alone, 1 c.c. of $CO_2$ being taken as equivalent to 5.856 calories. L. Hill and Campbell have criticized the results of Waller and De Decker on two main counts: (1) the short duration of the period of taking the sample; and (2) the failure to take sufficient account of the increase of metabolism due to taking food.

Orr and Kinloch show that the great source of error inherent in Waller's rapid method is the neglect of the significance of the respiratory quotient in determining the caloric equivalent of the volume of $CO_2$ exhaled. Variations in diet are shown to affect the respiratory quotient markedly. If this factor is neglected and the energy expenditure calculated from the $CO_2$ output alone, it is shown that a 15 per cent. error may readily result.

The authors also show that the respiratory quotient may fluctuate as a result of sudden increases and decreases of the rate of work. They therefore caution against the use of the method of estimating the cost of work from $CO_2$ exhalation alone unless the factor of diet is under control and unless the actual collection of $CO_2$ is made some minutes after the beginning of the task and when the normal respiratory relations for the work in question have been established. — C. K. Drinker.

The Physiological Cost of Muscular Work. *Leonard Hill* and *J. A. C. Campbell.* Brit. Med. Jour., May 21, 1921, No. 3151, 733–734. — Waller and De Decker have given the cost of muscular work of colliers, shoemakers and others as measured by the exhalation of $CO_2$. The authors have carried out experiments of a similar nature using a bicycle ergometer and have compared the results obtained by Waller's method of calculation with those gained by the standard Douglas bag method in which both the $CO_2$ output and oxygen use are measured and the heat loss calculated therefrom.

The results by the two methods rarely agree and two causes are assignable: (1) Waller's method uses a thirty second period for collection of the expired air — too short a time for satisfactory collection; (2) the taking of food apparently affects Waller's method markedly. — C. K. Drinker.

The Correlation between Motor Control and Rifle Shooting. *Reynold A. Spaeth* and *George C. Dunham.* Am. Jour. Physiol., June 1, 1921, 56, No. 2, 249–256. — The conclusions reached are as follows: "From the foregoing experiments it is clear that steadiness is definitely associated ($\rho = +0.61$) with marksmanship in the case of men who have had range experience. The practical value of a test of this sort lies in its use as a predictive means of selecting probable expert rifle material and eliminating men who are physiologically unfitted to qualify as marksmen. Since the steadiness test requires only about 3 minutes

per man, it would be far more efficient as regards time, cost of munitions and the nerves of men and officers to select material for elimination or range development by this test rather than by the slow and costly method of giving every man a try-out with the rifle. In our experiments we have, however, only tested the test on men of known ability. It remains for future work to show how extensively this test may be used with raw recruits. Range practice may increase a man's steadiness and, conversely, steadiness practice may improve a man's range score. Further experiments alone will tell." — C. K. Drinker.

The Effect of Short Spells of Rest on Physical Efficiency as Measured by a Bicycle Ergometer. *Lucy A. Wallrich* and *Percy M. Dawson.* Am. Jour. Physiol., July 1, 1921, 56, No. 3, 460–463. — "1. When exercise is *heavy*, efficiency is increased by spells of rest.

"2. When exercise is *light*, efficiency is decreased by spells of rest.

"3. The neutral point, *viz.*, where work is neither light nor heavy, varies with the individual.

"4. The neutral point varies in the same individual depending on practice and physical condition (training)." — C. K. Drinker.

The Relation of Health to Atmospheric Environment. *Leonard Hill* and *M. Greenwood.* Internat. Jour. Pub. Health, May–June, 1921, 2, No. 3, 232–247. — This article consists of two sections, Part I by Leonard Hill, and Part II by M. Greenwood.

*Part I.* — The body is fashioned for the getting of food by outdoor exercise. It is singularly adapted to resist cold and exposure, and when assailed by the hothouse conditions, which make so large a part of man's environment, tends to react unfavorably. Abundant outdoor exercise in all sorts of weather and the assurance of a favorable indoor climate are most important elements in the attainment of good health. The author is particularly interested in measures which will result in furnishing a proper indoor climate. The most important feature which has been neglected in considerations of indoor life depends upon the cooling power of the air. Hill has devised the kata-thermometer to measure the cooling and evaporative powers of air. The instrument is simply a large spirit thermometer which is heated to 100°F., and the time taken for its fall to 95°F. The operation is repeated under wet bulb conditions and the difference between the two determinations gives the evaporative cooling power. (A minor calculation is involved.)

Extensive observation shows that the dry "kata" cooling power is given by the figure 6 in ordinary rooms occupied by sedentary workers. It was often found as low as 3 and 4 in poorly ventilated rooms but should never fall so low. When heavy work is being done the cooling power of the air should be kept in proper relation to the work done and the heat output of the worker. The body spends four times as much energy in heat as in doing external work, and if the atmosphere is so regulated as to prevent overheating and profuse sweating the worker will naturally be stimulated to a greater output. The heat output of different classes of workers is exemplified by the following estimates:

| | Additional K. Cal per Hour Required for Work |
|---|---|
| Tailor | 44 |
| Carpenter | 116–164 |
| Stonemason | 300 |
| Man sawing wood | 378 |

Hill has calculated that the tailor would require a dry kata cooling power of 6, the carpenter 8.10, the stonemason 15, and the man sawing wood 18 to keep him from sweating.

Observations should be accumulated in which working efficiency and cooling power of air are correlated.

*Part II.* — A general statement of the relation of tuberculosis to environment is made the basis of discussion as to progress in preventive medicine. We apparently have a fairly good knowledge as to what climate, food, housing, etc., will do to the individual. We are inadequate in measuring how far the rules we know are or can be obeyed. "We have pointed out that in one important instance, that of atmospheric changes, the methods universally employed a few years ago and very generally relied on now are inadequate. Research prosecuted on these lines will not lead to the discovery of new specific 'causes' of disease; it will fulfill a higher and, from the standpoint of preventive medicine, far more important purpose, *viz.*, the revelation of how life may be lived under physiological conditions." — C. K. Drinker.

Chemical Factors in Fatigue. I. The Effect of Muscular Exercise upon Cer-

TAIN COMMON BLOOD CONSTITUENTS. *Norris W. Rakestraw.* Jour. Biol. Chem., Aug., 1921, 47, No. 3, 565-591. — "1. An investigation was undertaken on twenty-one human subjects to determine the changes produced by severe muscular exercise upon the following constituents of blood and plasma: non-protein nitrogen, urea, sugar, uric acid, preformed and total creatinine, cholesterol, and hemoglobin, as well as specific gravity, viscosity, and the number and relative volume of corpuscles.

"2. Two types of exercise were employed, representing short, strenuous effort and longer, more tedious work.

"3. Short, strenuous exercise was invariably found to increase the blood sugar concentration both in plasma and corpuscles, while a longer period of exercise was generally accompanied by a drop in blood sugar, which was greater in the plasma than in the whole blood.

"4. Both kinds of exercise were accompanied by a small increase in uric acid, of about the same order, which was greater in the plasma than in the whole blood.

"5. Short, strenuous exercise had no effect upon urea or non-protein nitrogen, but longer work increased both slightly, in whole blood as well as plasma.

"6. In both types of exercise the total creatinine increased very little, while the preformed creatinine underwent almost no change.

"7. It is shown conclusively that there were no considerable changes in the total blood volume during the muscular exercise and that variations in the concentration of the blood are not, therefore, disturbing factors in the above conclusions.

"8. Cholesterol was found to decrease very slightly, although results were not thoroughly consistent. The decrease seemed to be somewhat more noticeable in the corpuscles than in the plasma.

"9. The specific gravity, hemoglobin, and the number and relative volume of corpuscles were found to increase during the periods of exercise. The viscosity of the whole blood was found to increase considerably and that of the plasma slightly.

"10. Some incomplete data are given suggesting that total nitrogen is increased in the blood by exercise and that urea, non-protein nitrogen, and uric acid continue to increase for some time after a work period, while the sugar concentration, on the other hand, returns to normal within two and a half hours." — A. S. Minot.

PRACTICAL EXPERIMENTS IN SEATING IN INDUSTRY. *Edith Hilles.* Nation's Health, July 15, 1921, 3, No. 7, 399-405. — "Fortunately," according to Miss Hilles, it is "coming to be true that manufacturers who employ large numbers of workmen are slowly discovering that it pays in dollars and cents to study the postural needs of their employees, and to provide for them an environment suited to their needs." The author goes on to discuss practical experiments with a good type of adjustable foot rest; with a foot pedal which swings backward and forward instead of up and down, thereby sparing the operator much fatigue; and with seats, both sliding and stationary, for different types of work. The discussion is accompanied by a number of photographs which illustrate good and bad points in seating equipment.

The incentive for considering what good posture is and how to provide for it may be an economic one coming from the industrial engineer who wishes to increase production; the management may have a humanitarian motive in seeking to improve the seating facilities for its employees; or the workers themselves, weary of unnecessary discomfort and fatigue, may request better seating equipment. Miss Hilles quotes an interesting case of "a hosiery mill where the workers in one department formally submitted a request that chairs be used in place of stools. They gave three reasons for making this request:

"'We can do better work.

"'We can increase production.

"'We can go home at the end of the day without pains in our backs and the possibility of being absent the next morning from work because of a headache from the constant strain of leaning over our machine all day with no chance of relaxation.'" — Katherine R. Drinker.

## WOMEN AND CHILDREN IN INDUSTRY

The New Place of Women in Industry — VI. The New Industrial Professions. *Ida M. Tarbell.* Indust. Management, Aug. 1, 1921, 62, No. 2, 106–108. — "In this closing paper of the series, Miss Tarbell discusses the new professions which have opened themselves for women as an outgrowth of the expanding interest in personnel work. In all industry there is probably no work of greater importance, surely none in which a woman's special gifts of tact and sympathy count for more, than in the 'humanizing' of relations between employer and employee." — M. C. Shorley.

Listing the Work of Women. *M. E. Shubert.* Factory, July, 1921, 27, No. 1, 120, 122. — This is a résumé from the bulletin of the U. S. Department of Labor of the laws passed in various states on women in hazardous industries. Pennsylvania prohibits the handling of lead by women; New York prohibits working with abrasives; Ohio prohibits working wheels or belts of any sort; and Louisiana prohibits the oiling or cleaning of moving machinery. In various states the lifting of weights is regulated by law. — M. Dent.

Causes of Work Accidents among Women. *Nelle Swartz.* Nation's Health, June 15, 1921, 3, No. 6, 367–369. — This same material was covered by Miss Swartz in the Bulletin of the New York State Industrial Commission, and was reviewed in the June, 1921 issue of This Journal, on page 27 of the Abstract Section. — G. E. Partridge.

Physical Standards for Child Laborers. *S. Josephine Baker.* Nation's Health, July 15, 1921, 3, No. 7, 420–423. — The National Child Labor Committee has recently stated that:

"1. There are at least five and a half million illiterates in the United States.

"2. Nearly one-fifth of all American children between the ages of ten and fifteen are out of school, earning their own living.

"3. Illinois, Iowa, Kansas, Maryland, Minnesota, New York, Pennsylvania, Texas and Wisconsin all report a startling increase in the number of children leaving school to go to work in the year 1920."

According to these statements, we have in the United States approximately 2,200,000 children, from 10 to 15 years of age, engaged in some form of industrial occupation, the tendency being for this figure to increase rather than to decline. When we consider that "the child who goes to work at fourteen has an earning capacity at twenty-five just half as great as the child who stays in school until he is eighteen; and that the child who goes to work at fourteen is twice as liable to sickness and disability as the child who stays in school," we realize the incalculable loss to the nation in health, efficiency and happiness created by premature employment.

Dr. Baker believes that a minimum standard age of 16 years should be established in all states for the entrance of children into industry; that an employment certificate should always be issued for a particular job and in the name of the employer; that no new certificate should be issued unless the child has had a physical examination and is shown to be in sound health and physically fit to perform the work he intends to do; and that a child continuously employed in any position for more than one year should have a yearly physical examination.

The examination of any "child before he enters industry should cover the following points: height, weight, general physical condition, condition of nutrition, maturity, examination of the skin, eyes, ears, mouth, nasopharynx, glands, heart, lungs and abdomen. Orthopedic defects should be noted, and diseases of the nervous system and disturbance of the menses are also of importance.

"The standards of height and weight which have been used by the Department of Health of New York City for a number of years are:

| | | |
|---|---|---|
| "Fourteen years | 58 inches | 80 pounds |
| "Fifteen years | 58 inches | 85 pounds |
| "Sixteen years | 59 inches | 90 pounds |

"When a child is found to be 10 per cent. below the proper weight for his height, he should be examined by two physicians to determine whether this underweight is the result of undernourishment or other bodily defect or whether it is a racial or family characteristic."

In the case of certain types of physical defect which may be easily remedied, certificates are temporarily withheld and only where treatment is not obtained after a reasonable length of time is the certificate refused permanently.

"Physical defects which justify permanent refusal are: (1) cardiac diseases; (2) tuber-

culosis or other evidence of serious pulmonary disease; (3) tuberculous or syphilitic disease of joints and bones; (4) irremediable defective vision; (5) trachoma; (6) serious orthopedic defects; (7) malnutrition, equivalent to grade 4 of the Dunfermline scale; (8) chorea; or (9) total deafness.

"Every effort is made to see that children who are refused employment because of physical defects are referred to some appropriate person or agency for whatever medical or other assistance is needed. Temporary refusal is based upon the following defects: (1) defective vision subject to correction by lenses; (2) contagious eye and skin diseases; (3) defective teeth; (4) malnutrition equivalent to grade 3 of the Dunfermline scale; (5) untreated hernia; (6) hypertrophied tonsils, where there is evidence of serious obstruction or diseased condition; (7) defective nasal breathing, causing complete obstruction of the nostrils; or (8) tuberculous glands.

"All children who are temporarily refused employment certificates because of the existence of physical defects which may be curable under proper treatment, are referred to the care of the school nurse of the Bureau of Child Hygiene who assumes responsibility for the case and makes every effort to see that the necessary medical treatment or other care is secured for the child. When such care has been provided and the physical defect has been corrected, the employment certificate is issued.

"The application of such standards to New York City has resulted, in the year 1919, in the absolute refusal of 3.17 per cent. of all children who applied for employment certificates, on the ground of physical defects" which could not be corrected. "During 1919, 49,294 employment certificates were granted and 2,306 were refused. By far the greater number of these were refused because of physical incapacity (1,688). The other classifications were insufficient tuition, 44; insufficient education, 10; under age, 27; over age, 557."

In determining the physical status of a child and his fitness to be employed, race and nationality, age and sex, family history and intended occupation should all be taken into account. — Katherine R. Drinker.

Effect of the War on Working Children in Germany. *Anna Kalet.* U. S. Bur. Labor Statis., Month. Labor Rev., July, 1921, 13, No. 1, 6–17. — This article is based on the reports of the factory inspectors of the various German states for the years 1914 to 1918 and includes a discussion of the following topics: extent of child labor; suspension of legal restrictions on child labor; difficulties of labor law enforcement; apprenticeship; continuation schools; exemptions from elementary school attendance; conduct of working children; industrial accidents to working children; health of working children. — R. B. Crain.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Industrial Sanitation Affects Public Health. *S. Dana Hubbard.* Nation's Health, July 15, 1921, 3, No. 7, 415–419. — The author first discusses the importance of proper water closet facilities in industrial establishments, the necessity of regular cleaning, of prompt repairs in case of damage, and of constant supervision. Water closets should be located within the factory, preferably on each floor and with an outside exposure in order to secure light and ventilation. The water closets "should be in charge of a committee of workers — the shop sanitary committee — whose duty it should be regularly to inspect these places and report, on special cards furnished, the conditions found on each inspection. . . . This committee should be changed sufficiently often to give each employee of the shop an opportunity to serve and in this way become familiar with house sanitation" and its necessities. "Shortage of toilet paper and the stopping up of basins would be detected promptly and opportunity given to have such corrected before it put the apparatus out of order. In one establishment alone this cut the expense of toilet operation 50 per cent. in less than one year."

The following standard toilet equipment is suggested as sanitary, practical and efficient:

"(1) Location on outside wall, for light and ventilation.

"(2) Solid porcelain closets with open front type of seat (horseshoe shaped), the seat auto-

matically flushing the tank and after use raises so as not to be wetted in case this basin is used as a urinal by men.

"(3) Each closet to be enclosed in metal and furnished with automatic closing doors. The doors to have an inside bolt to insure privacy.

"(4) Each toilet to be at least 90 cubic feet in area.

"(5) Floor to be concrete, pitched to a floor drain.

"(6) Hose bibb water supply for flushing and washing. Every toilet to be washed with a disinfectant every day.

"(7) One toilet for every five or multiple of five workers.

"(8) Full length porcelain urinals equipped with water supply for constant flushing and separated by a full length screen to insure privacy. The urinal to be set on a slate slab with concrete border, tapered so as to form drain to waste."

Dr. Hubbard next discusses the importance of a proper drinking water supply accessible to outdoor as well as to indoor workers, the location of the water supply tank, the importance of providing individual drinking cups or installing drinking fountains, and the necessity for providing waste receptacles for water left in the drinking cups.

Workmen should have a clean, secure place to hang their clothes and hats and to leave their lunch boxes — preferably metal lockers on legs some distance from the floor. Lockers should be separate for the sexes, should be fire and vermin-proof, should be placed in a location so as not to absorb odors, should be properly ventilated and of sufficient size to permit garments to be hung without crushing. Each locker should have a key which should be in the possession of the user. Lockers should be systematically inspected and cleaned at least once a week. Every Saturday, for example, all lockers may be emptied to permit scouring.

Each industrial establishment should provide suitable wash basins, preferably supplied with hot and cold running water and with soap and individual towels. Where the trade involves an unusual amount of dirt and grime, such as firing, oiling, coal handling, garage work, etc., where there is much dust, as in flour and plaster mills, or where fumes or poisons constitute a hazard, as in dyeing, shower or tub baths should be provided and workmen should be encouraged to bathe before leaving for home.

Dr. Hubbard emphasizes finally the value to industrial establishments of lunch rooms which supply economical, well balanced, and suitable lunches for employees. — Katherine R. Drinker.

How Paint Affects Waste. *P. F. O'Shea.* Factory, July, 1921, 27, No. 1, 66. — When oil tanks and gas containers are painted black or dark colors a rapid absorption of heat takes place and considerable loss by evaporation occurs. "Black paint allows nearly two and a half times as much heat as white to penetrate to the contents. . . . The following table shows the rise in temperature of benzine, which does not differ much from gasoline, in small tanks when subjected to the rays of a carbon arc for fifteen minutes:

| "Color | Degrees Fahrenheit |
|---|---|
| Tin plate | 19.8 |
| Aluminum paint | 20.5 |
| White paint | 22.5 |
| Light cream paint | 23.0 |
| Light pink | 23.7 |
| Light blue | 24.3 |
| Light gray | 26.3 |
| Light green | 26.6 |
| Red iron oxide paint | 29.7 |
| Dark Prussian blue | 36.7 |
| Dark chrome green | 39.9 |
| Black paint | 54.0." |

— M. Dent.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

The Medical Department in Industry. *Marvin Z. Westervelt.* Nation's Health, Aug. 15, 1921, 3, No. 8, 457–461. — This article, based upon the activities of the plant hospital of the Winchester Repeating Arms Company at New Haven, Connecticut, is a presentation of the problems of the medical department in industry, considering its field, its functions, its relationship to other departments and its future. There is reported "a loss through infections amounting to 0.00003 per cent. for a period of three years." In but two cases out of 54,958 did an employee lose any portion of his body due to infection. The author emphasizes the importance of co-ordination in the medical department with other plant activities.—Wade Wright.

The Routine Physical Examination of the Worker *Charles K. Ervin.* Nation's Health, Aug. 15, 1921, 3, No. 8, 464–466.— This is a consideration of physical examination in an industrial medical establishment. Emphasis is placed upon the importance of a complete and careful physical examination, the proper filing of records and the value of the physician's examination of the labor applicant as an index of his desirability. — Wade Wright.

The Health Service Side of Personnel Management. *E. B. Morgan* and *S. J. Repplier.* Indust. Management, July 1, 1921, 62, No. 1, 43–47. — The aim of the Medical Division of the Curtis Publishing Company is to be the family doctor of the employees, and not merely to examine applicants for refusal or acceptance, or to take care of industrial accident cases. In order to accomplish this, it was necessary — in so far as possible at the time of the first contact with the new employee — to remove the impression that the medical department was only an examination bureau. The first step was to abandon the physical examination as a requirement, and to substitute a consultation, in which the nature of the work is explained and the man helped to see whether he is fitted to undertake it. The service of the medical division is described before any specific problems of the health of the workman are taken up. The course of conversation is gradually directed to these personal points, but an examination is not given unless the applicant has been led to desire it as a matter of health service, except when some exceptional hazard is suspected.

Although, by not insisting upon a thorough routine examination, some workers are admitted who might otherwise be rejected, it is believed that the advantages of the plan more than offset the disadvantages. On this new plan, which has been in operation for a year, visits to the hospital have trebled. It is argued that, since the formal examination is of little value without re-examination, the increased opportunity, on the new plan, for observing the condition of employees plus the information gained during the first interview represent a decided gain. Another result is that the medical service is used by officials as well as by the rank and file. — G. E. Partridge.

Health Service of Illinois Bell Co. *W. E. Crosley.* Hosp. Management, July, 1921, 12, No. 1, 56, 58. — The health department of the Illinois Bell Telephone Company supervises medical and accident service for about 15,000 employees and conducts physical examinations of all applicants. The number of cases treated in recent months has ranged from 2,900 to 4,900 (including all visits made to the department). Dental examinations are given, including X-ray, and an arrangement is made with a specialist for necessary examinations of the lungs or chest. There are but few hazards and not many serious accidents, but in each of the exchanges there is a first-aid kit for emergency. The health department also has the assistance of fifteen visiting nurses who are connected with the welfare department.

Applicants are graded in several classes according to the results of their physical examinations: class A includes all who are in perfect health; B 1A, those having slight defects; B–1B, those who need watching; B–2, those unfit for certain kinds of work; and C, the entirely unfit. The examiner merely ascertains the facts, and the final authority is the employing department.

The health department does not undertake treatment, except in simple cases, but devotes its efforts to ascertaining conditions, giving advice and endeavoring, without exerting any compulsion in regard to its services, to be helpful to the employees of the company. — G. E. Partridge.

Standard Oil Company Health Service. *J. M. Adams.* Hosp. Management, Aug., 1921, 12, No. 2, 90, 92. — Under the "annuities and benefit plan," the employees of the Standard Oil Company of Louisiana have free life insurance; are paid half-time in case of disability resulting from sickness; and are given annuity in old age. The annuities range from a minimum of $25 per month to 75 per cent. of the wages, and the death benefit ranges from $500 to $2,000. There is a safety department, working in co-operation with the medical department, and a meeting, attended by all foremen, is held each week at which the accidents of the previous week are discussed. Bulletins and posters are displayed about the plant, showing the effects of neglecting slight injuries. Workmen are required to report every injury, however slight. Emergency boxes, with stretcher, blankets, tourniquet, and large dressing and burn packets, and resuscitation and rescue out-

fits are provided. Accidents are posted on a large bulletin board.

There is a company hospital of five rooms, in charge of two full-time physicians, two graduate nurses, and three first-aid men. All persons employed are examined. Sickness cases are supervised by a visiting nurse. There is ambulance service for cases requiring removal, and serious cases are sent to sanatoriums after first-aid treatment. All employees who have reached the age of 65 years are examined semi-annually, as are all persons who are subject to occupational diseases. Special provision is made for the treatment of tuberculosis cases, with sanatorium treatment when advisable, and necessary aid is given to dependents when such cases require special treatment. — G. E. Partridge.

Welfare Work of Continental Motors. Hosp. Management, June, 1921, 11, No. 6, 56. — The following summary of the latest annual report of the first-aid department of the Muskegon Plant, No. 2, of the Continental Motors Corporation indicates in a general way the service rendered and its cost:

Number of employees, 4,200.
Injuries treated (minor and serious), 11,041.
Redressings, 12,209.
Total treatments, 23,250.
Fatal infections, 1.
Days lost through accident, 2,075.
Compensation paid, $9,075.10.
Medical and hospital first aid, $7,309.45.
Salaries, $8,273.23.

"The company handles its own liability insurance and, according to J. R. Anderson of the compensation department, an actual saving of $48,233.88 was made, this including the plant at Detroit where there are 3,000 employees." The first-aid department at Muskegon is in charge of a full-time physician, whose assistants include two graduate nurses and a stenographer who is also record clerk. All new employees are given a physical examination — a rule to which the company has as yet met no opposition.

The welfare department of the Continental Corporation some time ago made an investigation into methods of inducing employees to report to the first-aid room, no matter how trivial their injuries might appear, and as a result of this investigation the word "hospital" was discarded and "first-aid department" substituted. Many of the employees, it was found, disliked the thought of going to a hospital, but readily made use of the facilities of the department when it was called "first-aid." — M. C. Shorley.

Dentistry as a Production Factor in Industry. *A. A. Crocker.* Nat. Safety News, June, 1921, 3, No. 16, 15. — Dentistry was placed on the safety program of the Fourth Annual Safety Congress of the National Safety Council in 1915, and since that time has attracted increasing attention in industry, until now more than one hundred and fifty companies operate dental clinics. Experience has shown that as a result of the greater attention to dental work, there has been a noticeable reduction in such troubles as colds, headaches, rheumatism, boils and nervous troubles. — G. E. Partridge.

## INDUSTRIAL NURSING

What an Industrial Nurse can do for a Community. *B. W. Adams.* Pub. Health Nurse, June, 1921, 13, No. 6, 291–292. — The American Smelting and Refining Company has maintained at its East Helena plant for the past six years a safety and service department, and about two years ago an industrial nurse was appointed, whose work extends to the welfare problems of the community. The first work taken up was the examination of the 273 children attending the schools (199 were found physically defective), and the correction of malnutrition by providing free milk for about a quarter of the children. A crusade for good health has been conducted in the schools. A Mothers' League has been formed and training is given in the care of infants and young children. Home visits are made by the nurse, who combines general social service with the special work of her profession. All this she does in addition to regular duties in the plant, where a dispensary and first-aid stations are maintained, and classes held, attendance upon which is compulsory for foremen.

"The good that a nurse can do in a community is limited only by her own capabilities. It is certain that there is a vast amount of work that can be accomplished in the average industrial community if the proper steps are taken in the beginning," and the first step is the selection and appointment of a qualified visiting nurse. — G. E. Partridge.

## INDUSTRIAL PERSONAL AND COMMUNITY HYGIENE: HOUSING, ETC.

EMPLOYEES AND HOMES. *R. E. Jamieson.* Factory, June 1, 1921, 26, No. 11, 1356. — A project formed by employees of the Western Electric Company's plant in Chicago, which includes two plans, "one with the aim of learning the cost for those who desire to build, and the other, of financing a plan of the building and loan type." The organization and different sorts of stock are herein outlined. — M. C. Shorley.

FRAMINGHAM COMMUNITY HEALTH AND TUBERCULOSIS DEMONSTRATION. CERTAIN MEDICAL RESULTS. *Donald B. Armstrong* and *P. Challis Bartlett.* Jour. Am. Med. Assn., Aug. 20, 1921, 77, No. 8, 585–587. — The authors summarize as follows: "The chief factors that seem to be responsible for the late discovery of tuberculosis cases which give to the community every year advanced and dying patients that have not been known or treated for tuberculosis in the early stages of the disease are: the recluse type, which seems to be the main type, never receiving any medical attention; failure of patients to seek medical advice early, or, if they do, not to give the physician sufficient time to make a diagnosis; occasional failure of physicians to detect disease early; failure of both physician and patient to use all of the services at their command for early diagnosis of tuberculous disease; lack of complete annual medical examination, and lack of annual factory and school examinations." — C. K. Drinker.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

A STATISTICAL STUDY OF LABOUR TURNOVER IN MUNITION AND OTHER FACTORIES. *Gladys M. Broughton* and *Ethel M. Newbold.* Indust. Fatigue Research Board, Rep. No. 13, London, 1921, pp. 92.—The investigators conclude that:

1. High labor turnover is not confined to war-time industries.
2. Married women shift their positions more than single women.
3. The effect of a permanent night shift cannot yet be determined.
4. It is believed that former factory or munition workers are more unstable than those drawn from other sources.
5. "The loss from possibly avoidable reasons, such as ill health, incompetence and dissatisfaction, is very large." — M. Dent.

## INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

PERSONNEL MANAGEMENT OF THE METROPOLITAN LIFE INSURANCE COMPANY. *L. Washington.* Indust. Management, July 1, 1921, 62, No. 1, 27–32. — The system of personnel management described is one that is applied to a force of about 6,000 workers, and includes employment, records of turnover, labor saving, position analysis, grades and salary increase, ratings, promotions, transfers and dismissals, etc. A detailed procedure is followed in selecting employees, including both mental and physical examinations. The requirements for each position are considered and the department endeavors to fill the position with the best qualified man. Very well qualified applicants are sometimes appointed, even if there are no positions open which they could fill, and are assigned to the "Utilities Bureau," to do such work as is available, and are later assigned to suitable positions. A personal history is kept

for each employee, and a system of rating somewhat like the army method is carried out. Promotions and demotions are made on the basis of the records. Each position in the office has been analyzed, and a grade assigned to it, according to the difficulty and responsibility of the work, and upon this basis the salary is fixed, in connection with rating. Twenty-nine different grades of position are recognized. By this system a definite limit of salary is placed upon every position, but not upon the individual, since he is always potentially a candidate for a more advanced position.

There are many provisions for the health of employees, such as a tuberculosis sanatorium and rest house, luncheons for the employees of the home office, a free medical dispensary, free dental examination and prophylaxis disability insurance (paid partly by the company and partly by the employee), free life insurance, a staff savings fund, to which the company contributes an amount equal to 50 per cent. of the amount deposited by employees, a library, various educational courses and other services. Another part of the work of the personnel division is to increase individual production and to perfect organization and methods. — G. E. Partridge.

A Note on Intelligence Tests. *W. Johnson.* Jour. Neurol. and Psychopath., Feb., 1921, 1, No. 4, 325. — The author gives a brief account of the various tests, applications of methods, practical utility and scope of the measurement of intelligence, and summarizes as follows:

"1. There is no sharp demarcation between grades of intelligence. . . . The so-called normal child easily forms the largest proportion and composes the central bulk of the group. . . .

"2. The occurrence of high intelligence is as frequent as that of extremely low intelligence.

"3. There is no particular year in which individual mental variability is especially marked, a group of children six years old showing as much variation individually as does a similar group, age fourteen years.

"4. As regards sex, it is found that below fourteen years girls are slightly more intelligent than boys, but after that age the advantage swings slightly to boys.

"5. Children from the higher social status are slightly above the normal intelligence, and those from the inferior slightly below it.

"In the course of time, no doubt, the development of intelligence tests will proceed towards the direction of its application to adults. Their scope will then be considerably widened. They may possibly provide us with the much-needed guide for the selection of particular individuals for particular work or professions, as well as providing a certain definite indication that a certain individual is entirely unsuited for a certain employment or career. That such important decisions — which in young adults are not infrequently life decisions — are left largely to chance is a misfortune which doubtless has produced, and will continue to produce, dire consequences in many a life. From many aspects, therefore, the advance in the study of comparative intelligence will prove of the greatest practical utility. The progress which has already been made in the subject has established it on a permanent foundation. The superstructure remains to be built." — C. K. Drinker.

## INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Welfare Provisions That Help. *B. M. Thompson.* Factory, July, 1921, 27, No. 1, 116, 118. — The following suggestions are made, taken from the New Orleans and Louisiana Industrial Survey: Every shop should contain washing facilities, inside toilets, workroom floors clean and dry, dressing rooms and rest rooms, modern ventilation and lighting, and drinking facilities. The lunch hour should be at least forty-five minutes long, there should be rest periods in the forenoon and afternoon, seats for women workers, and uniforms. "Changes in work or processes should be recommended or ordered if necessary, to do away with: constant standing or other posture causing physical strain; repeated lifting of heavy weights, or other abnormally fatiguing motions; operation of mechanical devices requiring undue strength; exposure to excessive heat or cold; exposure to dust, fumes, or other occupational poisons, without adequate safeguards against disease." — M. C. Shorley.

# INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

New York Labor Laws Enacted in 1921. *Henry D. Sayer.* N. Y. State Dept. Labor, Bull. No. 107, July, 1921, pp. 68. — "This bulletin presents the Governor's recommendations for reorganization of the Department of Labor and for prompt payment of workmen's compensation, the texts of two legislative resolutions continuing the joint committee for reeodification and revision of the labor statutes and the texts of twenty-nine labor chapters of the Laws of 1921, of which four amend Chapter 50, the recodified Labor Law, and three amend the Workmen's Compensation Law. It also outlines the recodification of the Labor Law and the reorganization of the Department of Labor, as effected by Chapter 50, without giving the text of such chapter, and notices certain other chapters, mainly relating to public employees, without giving their texts." — M. Dent.

Court Decisions on Workmen's Compensation Law January, 1920 — June, 1921. Constitutionality and Coverage. *L. G. McConachie.* N. Y. State Dept. Labor, Bull. No. 106, July, 1921, pp. 302. — This bulletin covers the period, January 1, 1920 to July 1, 1921, and taken with the three previous bulletins "presents court decisions and the full texts of court opinions upon the Constitutionality and Coverage of the New York Workmen's Compensation Law from the time of its origin." — M. Dent.

What Constitutes a Fair Estimate of Loss of Use of Eye in Workmen's Compensation Cases? *William Mehl.* Med. Record, May 14, 1921, 99, No. 20, 826-828.— In eye cases there is a regrettable lack of standardization for fixing the percentage of vision sustained by injury. The Snellen test is the usual means of reporting upon cases but the interpretation of findings varies markedly in different parts of the country. Thus "a man whose central visual acuity has been reduced to 20/40ths is supposed to have a 50 per cent. eye in New York, an 89 per cent. eye in Illinois, and a 94 per cent. eye in Wisconsin. In other words, a man who is told in New York that the efficiency of his injured eye has been reduced by one-half learns in Illinois that he really lost only 11 per cent., and in Wisconsin he will be assured that he suffered an impairment of only 6 per cent." These differences arise as a result of failing to permit the figures of the Snellen test to stand for what they are. They should be used without any additional interpretation or modification. Then 20/40ths means 50 per cent. loss of vision, 20/60ths means $66\frac{2}{3}$ per cent. loss, and 20/80ths means 75 per cent. loss.

"Accidents causing loss of field (peripheral) vision alone are of such extremely rare occurrence that the average injury to the eye should not be minimized by the thought that perhaps the field (peripheral) vision had sustained a less serious loss than the central vision. And as regards binocular vision, I hold that every impairment of central vision affects it in some measure. Furthermore, estimates of the degree of field vision which is supposed to have been lost would be so much a matter of pure conjecture that I doubt if any two examining oculists would ever agree as to its exact amount." — C. K. Drinker.

What Principle must Govern Estimates of Visual Loss in Compensation Cases? *William Mehl.* Med. Record, Aug. 6, 1921, 100, No. 6, 237-240. — "Where the law provides that compensation shall be awarded for a partial reduction of vision, examination by Snellen tests will establish what fraction or percentage of vision is lost. While these tests are confined to visual acuity, they are for all practical purposes the only reliable means for fixing loss of vision in general. . . . Tables fixing what amount of peripheral vision shall be assumed to exist when a certain fractional loss of visual acuity has been established, are arbitrary and unscientific.

"Loss of binocular vision is legally considered, in the State of New York at least, as equivalent to the loss of use of one eye. So this factor cannot be brought in to minimize the sustained impairment.

"If instead of the principle of insurance of physical impairment *per se* there is to be substituted the principle of economic loss, then the legislature will have to make the first move and determine a new governing basis for compensation awards. The logic of industrial, occupational, vocational or by whatever other adjective the loss may be characterized, when

the economic factor becomes the basic consideration, must of necessity lead to ultimate state monopoly of compensation insurance. These are matters which are of no direct concern to oculists as such and may well be left to be settled by experts in other departments of work.

"I have indicated a middle way which may bridge over the transition from compensation for the purely physical impairment of sight to compensation for the actual loss of earnings caused by a traumatic reduction of vision in each individual case. The middle course would take account of the loss of useful vision in a very general way by fixing the point of industrial blindness and requiring lesser impairments of sight to be rated by appropriate percentages. This course, too, must first have the sanction of legislative enactment before compensation boards can permit themselves to be governed by it." — M. C. Shorley.

A Report to the Medical Profession by the Medical Advisory Committee of the Massachusetts Industrial Accident Board. Boston Med. and Surg. Jour., June 2, 1921, 184, No. 22, 582-586. — A statement is given of the relation of doctors to insurers under the industrial laws. The report is mainly concerned with the compensation of physicians in the operation of the accident compensation law. — Barnett Cohen.

Results of Meniscus Operations after Industrial Accidents. *J. Dubs.* Abstracted as follows from Schweizerische med. Wchnschr., June 9, 1921, 51, No. 23, 529, in Jour. Am. Med. Assn., Aug. 6, 1921, 77, No. 6, 496. — "Dubs discusses the remote results and disability from the standpoint of accident insurance. His tables show that only 17.5 per cent. of the 40 insured workmen have regained full earning capacity since the operation on the ruptured meniscus, and 82.5 per cent. have received workmen's compensation for permanent disability. In Baud's similar series in men that were not insured against accidents, 80 per cent. have regained full earning capacity, free from any subjective or objective disturbances. His tabulated data teach that the decision as to the outcome of a meniscus injury should never be made until a year at least after the operation. Conditions which seem irreparable at first may gradually right themselves." — C. K. Drinker.

## REHABILITATION OF DISABLED EMPLOYEES

Salvaging Humanity a Social Necessity. *James P. Munroe.* Nation's Health, July 15, 1921, 3, No. 7, 383-386. — During approximately three years preceding May 1, 1921, the Federal Board for Vocational Education rendered decisions, through personal interviews by its agents, "upon the applications of approximately 350,000 ex-service men, . . . adjudged about two-thirds of them to be eligible for training under the rehabilitation law and . . . placed in training with maintenance pay or without pay . . . approximately one hundred thousand men." In the opinion of Mr. Munroe, vice-chairman of the Federal Board, "experience with this wide range of men, at least half of them below the median from the educational standpoint, and all of them below par from the physical standpoint, has demonstrated that, from the economic aspect alone, the salvaging of men is an investment which brings in colossal returns. Were the work of soldier rehabilitation eventually to cost the government half a billion dollars, it will bring back to the country, in increased earning capacity of the men so trained, at least four times that sum. . . .

"The case for the industrially disabled is not so clear, of course, as for those injured in a war for national preservation. It is equally plain, of course, from the economic standpoint; but from the social point of view one must go a little deeper to find full justification. That justification rests on the fact that, while a certain proportion of civilian disabilities are due solely to a man's or a woman's own carelessness or defiance of the laws of health, by far the greater number are due wholly or in great part to the conditions of economic or social life over which the individual has absolutely no control, but concerning which society could, if it chose, exercise far greater watchfulness than in fact it does. In other words, the vast majority of accidents and of disabling diseases are due to the increasing complexities of modern life only in slight degree controlled, as yet, by social regulation. So large a proportion, therefore, of civilian disability is the fault of society rather than of the individual, that there is as sub-

stantial justification, from the social standpoint, for the rehabilitation of those disabled in the normal pursuits of peace as for those injured in the abnormal pursuits of war.

"Whether, therefore, we view rehabilitation from the purely monetary aspect, that of conserving workers who hithertofore have been most wastefully thrown aside, or whether we regard it from the deeper and more enduring point of view of the good of civilization, it is seen to justify itself as one of the most important forward steps towards social well being that this country has ever taken. Theoretically, the arguments are unanswerable, and practically, those arguments have been proved as sounder even than their advocates believed, by the satisfactory economic and social results already achieved in connection with the rehabilitation of ex-service men. With such a demonstration as this, the states should have no hesitation in providing a generally similar scheme of rehabilitation for the immensely greater number of those disabled in the pursuit of their vocations or of their avocations, or even in the hazardous process of getting, under modern traffic conditions, from one place to another." — Katherine R. Drinker.

Status of Industrial Rehabilitation. Voc. Summary, May, 1921, 4, No. 1, 18–19. — The present status of industrial rehabilitation, as regards the relations of state and federal acts, is shown in a table, in which date of acceptance by governor and by legislature, date of certification to the United States Treasury, federal appropriation for 1920–1921 and for 1921–1922, and state appropriation for the same periods are given. Between the time of the passage of the act and January 1, 1921, the limit set for certification, to the United States Treasury, of the states entitled to receive federal money for the year ending June 30, 1921, thirty-two governors had proclaimed acceptance of the federal act.

The act requires that every dollar of federal money be matched by one from the state, and while there are certain other mandatory provisions in the act, the states have liberty to administer and maintain industrial rehabilitation as they deem best. All of the state acts provide for the work to be administered by the state boards for vocational education, but there are some slight variations as to methods of administration. In most of the states the scope of the law is as broad as the federal act, which includes any disabled person of employable age who has suffered a diminution of earning power because of some physical handicap, congenital or attributable to accident or disease. A few states have limitations as to length of residence required, and most of the states do not provide definitely for the maintenance of the disabled person while being trained.

Minnesota, by an amendment, now provides for support during training. The amount is fixed at $66\frac{2}{3}$ per cent. of the wage at the time of the injury for a period not exceeding twenty-five weeks, provided the injury received is such as to entitle to compensation for seventy-five weeks in the schedule of indemnities for permanent impairments, and provided that the industrial commission shall on application find that retraining is necessary, and shall make an order for such compensation. Wyoming has provided that $10 a week be given to disabled persons for maintenance during training, for a period not exceeding forty weeks. Pennsylvania makes provision of $10 a week with compensation (available only for those injured in industry) for not more than twenty weeks, unless extension be granted. North Carolina has set apart a sum of $5,000 to be used for maintenance of disabled persons during training. A few states have arranged for social service. — G. E. Partridge.

Industrial Rehabilitation in the United States of America. Internat. Labour Rev., Feb., 1921, 1, No. 2, 259–263. —The federal government of the United States has taken three important steps in promoting vocational education: (1) in 1917, the provision for normal persons in need of training when entering or after entering an employment; (2) in 1918, the provision of special measures for disabled ex-service men; and (3) in 1920, the adoption of a plan for the vocational rehabilitation of all disabled persons. The administration of all the measures was given to the Federal Board for Vocational Education, created by the first of these acts. The most significant departure in the United States from the ordinary governmental provision for rehabilitation is the recognition of the fact that it is quite as important to the national interests to rehabilitate the victims of industrial as well as of war accidents.

Under the Vocational Education Act, in order to receive an appropriation from the government, a state must formally accept the act, and must designate a state board to co-

operate with the federal board. The legislature must, likewise, accept the Industrial Rehabilitation Act, if an allocation is desired. The board designated may be the existing board under the Vocational Education Act, or a special board, but where a state board exists for the administration of workmen's compensation or employer's liability laws, the state legislature must provide for co-operation between the two boards. The report of the Federal Board for 1920 shows that the Vocational Education Act has made considerable progress; from 1918 to 1920, the number of persons enrolled in federally-aided teacher-training courses increased from 6,589 to 12,456. In 1920, twenty-three states had accepted the Industrial Rehabilitation Act, and the work was well begun, especially in the twelve states where action had been taken, before federal aid was available, to provide for general industrial rehabilitation.

The American Association for Labor Legislation has advocated the supplementing of legislation under the new act with amendments to existing accident compensation laws in order to co-ordinate them more effectively with the rehabilitation program, or to provide the special medical care that may be necessary for the restoration of cripples. It is urged that if compensation laws can be fitted into the system of industrial rehabilitation, so that disabled persons may be transferred to fresh occupations to which they are adaptable, employers will be somewhat relieved of the burden of accident compensation in cases of permanent disability, and a solution will be provided for the problem of industrial accidents from the point of view of the crippled worker. Some attempt has also been made to prevent the exclusion of partially crippled workers from suitable occupations, by the action of insurance companies. — G. E. Partridge.

THE INDUSTRIAL TRAINING OF DISABLED MEN IN THE UNITED KINGDOM. Internat. Labour Rev., May–June, 1921, 2, Nos. 2–3, 247–260. — The history of industrial training is briefly recounted, and the first step in the training of disabled men, as carried on under the Ministry of Labour, is mentioned as occurring in 1919. The purpose of the training is to make the disabled man capable of carrying on a manual occupation, and only those are eligible who were disabled by the war, or at least had disability existing when they were discharged from the forces.

The administrative bodies conducting the work consist of: (1) a central authority, the Training Department of the Ministry of Labour; (2) seventeen district organizations with a divisional director at the head of each; (3) about twenty National Trade Advisory Committees and about 350 local Technical Advisory Committees.

Reports are published by the Ministry of Labour in regard to openings in industry suitable for disabled ex-service men, and thus far there are reports on twenty-five special trades; tailoring, furnishing, leather goods, handsewn boot and shoe making, and boot and shoe repairing, gold, silver and allied trades, dental mechanics, tailoring (wholesale), boot and shoe manufacture, basket making, building, engineering, printing, picture-frame making, brush making, electricity (power and light), distributive trades, sign writing, musical instruments, vehicle building, glass, cotton, pottery, lace, clog making, surgical boot making.

The main features of the educational plan are said to be the decentralization and the large part played by the national and local committees. The divisional directors have extensive powers in their districts and this makes possible decisions with more intimate knowledge of cases. The general conditions of training are laid down by the national committees for each trade, and their local application is controlled by the local committees, which consist of representatives of employers and workers in the industries in question. The result is that definite conclusions have been reached about the best methods of training for each industry, and progress has been made which must have considerable effect upon general industrial education. On this plan, the training of the disabled men and their distribution among the trades become rather more the work of the employers and workers in the trades than of the government, which only intervenes to direct the discussions and to provide the practical means of execution, plant, maintenance allowances, etc.

Training may be given in one of three ways: (1) in private employers' workshops; (2) in technical schools; (3) in special centers established by the state. The first way is the most economical, but has the disadvantage that the man's special needs are likely to be ignored. Training in technical schools is especially suited

for men who already have a good general education, and the special centers were set up to combine the advantages of the other two methods. But even this method has its faults, since the training is likely to be too theoretical, although it tends to be more and more in favor.

"In principle, training consists of two periods: a preliminary period lasting from six to eighteen months, during which disabled men receive the maximum state allowance, and a period of improvement lasting on an average eighteen months, during which they receive a progressively increasing wage and a proportionately decreasing allowance from the state. At the end of the period the allowance ceases and the disabled man receives only his pension and his wages."

Statistics are given in regard to the number of men in training, etc., and it is said that on the whole the work has been successful, although there have been delays and opposition in some particulars, especially as unemployment has increased.

"In one year, or two at the most, the training of men disabled in the war will be complete, and the problem will then arise of utilizing the experience which has been acquired in the training of disabled men, and the institutions which have been established, for the industrial training of young persons, of men disabled in industry, and of workers who are obliged for any reason to change their trade."—G. E. Partridge.

Report of Activities of Bureau of Rehabilitation to January 1, 1921. Bull. Penn. State Dept. Labor and Industry, 1921, Vol. 8, No. 2, pp. 30. — This is a profusely illustrated account of the aims and activities of the Bureau of Rehabilitation in Pennsylvania. — M. Dent.

# ABSTRACT OF THE LITERATURE OF INDUSTRIAL HYGIENE

VOLUME III DECEMBER, 1921 NUMBER 8

## CONTENTS



## GENERAL

HEALTH IN INDUSTRY AND EFFICIENT PRODUCTION. *S. Dana Hubbard.* Nation's Health, May, 1921, 3, No. 5, 312–315. — A very large percentage of the industrial accidents and diseases which prevail in most industrial establishments are preventable through education. There are many individuals who utterly disregard regulations, and well laid plans of the employer are frequently set at naught through the ignorance of the worker.

Inadequate medical supervision has been responsible for an appalling number of permanently handicapped individuals. Preventive medicine is concerned in the careful study of each individual in order to detect physical defects in incipiency. It is short-sightedness to seek medical aid only when ill. In industry it is short-sightedness to try and operate a plant without medical sanitary supervision. It is likewise a grave error to have cheap, untrained doctors and nurses who are already responsible for too many permanently disabled workmen.

In this article much emphasis is laid upon the importance of general house-cleaning and orderliness in factories, which is conducive of a better morale as well as better health. — L. A. Shaw.

MEDICINE AS RELATED TO WORKERS AND PRODUCTION. *C. A. Andrews.* Nation's Health, Sept. 15, 1921, 3, No. 9, 505–506. — Ten or fifteen years ago no one cared very much about the health of workers; but now, after various false starts, the problems of industrial welfare are becoming better defined. The economic interests of both employer and worker are seen, and the more ideal values represented by the spirit of contentment, optimism and good Americanism. Opposition arose when the American Association of Industrial Physicians began its activities, but recent tendencies show a quite different conception of the responsibility of industry. There is now an ideal of "mutual interest and mutual service, the med-

ical profession has aroused itself from its old self-satisfied orthodoxy, and has produced a virile group, traveling new paths, honoring themselves and their profession, and making their profession of greater value to the community than it has been before." — G. E. Partridge.

The Physician's Viewpoint. *Otto P. Geier.* Nation's Health, Sept. 15, 1921, 3, No. 9, 510–511. — Dr. Geier emphasizes the importance of industrial medicine to industry not only as an agent for improving output per man but also as an important factor in establishing a better relationship between labor and capital.

The need of industrial medical service is indicated by the fact that from 35 to 40 per cent. of our young men proved unfit for military service. "When we stop to realize that our present mode of living and doing and earning has finally produced a type of manhood 35 per cent. of whom are deficient for war purposes we naturally ask ourselves whether this condition does not also measure the mental and physical deficiency of society as a whole in peace time. Then we naturally ask ourselves a second question, whether this physical and mental unfitness does not explain a great deal of the present unrest, the state of mind of many men toward society, toward labor, toward capital, toward organized industry.

"From long contact with the industrial clinic I developed the hope that in the industrial clinic we might have produced a better state of mind, both in the employee and in the employer, that will make for a better program of social relationship, a better type of citizenship. . . .

"What industry needs above all things is to have the honorable employer properly interpreted to the employee, and the honest employee properly interpreted to the employer, if we wish in the future to prevent the fierce conflicts between labor and capital. There must be a laying of the cards on the table between the man at the workbench and the man in the office, in order that the fellow in the office may understand the mind of the worker in the shop, and *vice versa* that the worker may understand the man in the office. They both must get the idea that the other fellow is a pretty decent chap after all when you get to know him.

"I believe that industrial medicine in a labor policy is something industry must reckon with. I think it can be made a most natural approach to the subject. There is nothing artificial about industrial medical service. It is needed, and it is used. It is never looked upon by the worker as just another mechanism for the employer's advantage, for good service of this type sells itself. It is usually set up by the employer who wishes to render a real service to his men, and in this it is unlike so many schemes of employee-relationship which were hastily organized to meet an emergency labor problem. But only a doctor of the right sort, it goes without saying, may render such service. Industry, however, must learn that out of a cheap doctor can come only a cheap result." — Katherine R. Drinker.

The Educative Potential in Industrial Medicine. *O. P. Geier.* Nation's Health, Aug. 15, 1921, 3, No. 8, 455–456. — The industrial physician needs to study the fundamental relations of industry in order to understand the function of industry, the scope of an industrial relations department, and the place of employment, training, health and sanitation, safety and social welfare as functions of such a department.

Various aspects of the work of the industrial physician are discussed: the need of self-education; the education of the worker to make use of the means of personal hygiene, etc.; the education of executives, etc., to see the economic value of good health, also to understand the responsibility of industry toward community health. The industrial physician must also conduct an educational campaign in his own profession, and he must help the movement toward supplanting the social reformer by the social worker and inducing the medical profession to take a more active part in public health matters. The health officer needs some enlightenment in regard to industrial conditions, and the community as a whole must be made to understand the basic value of health programs. Influence should be brought to bear upon legislators whenever legislation affecting the welfare of the worker is to be considered, and the industrial physician must be thoroughly informed on all relevant subjects.

All these needs should be brought clearly to the minds of the governors of medical schools, especially to impress the need for men who will think in terms of the community. Finally, the collective action of all industrial physicians is needed to influence the American Medical Association and to bring about the recognition of the industrial approach to medical problems and all that this implies. — G. E. Partridge.

# SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

## CIRCULATORY SYSTEM

Arteriosclerosis Localized in the Arteries of the Shoulder. *Torraca.* Abstracted as follows from Riforma med., 1921, No. 23, in Il Lavoro, June 30, 1921, 12, No. 2, 41–42. — A laundress 62 years old had begun six months before she was seen by Torraca to be conscious of an unusual sense of weakness in her upper limbs and at the same time a pulsation on the inner surface of both arms. Later on came formication in both hands and lightning pains. The two humeral arteries (upper brachial) appeared much dilated with serpentine course and an energetic pulsation, while palpation showed that they were both uniformly indurated. The author considers that this circumscribed sclerosis was caused by two factors: cold, and localized muscular over-exertion. The localization of sclerosis in these arteries is very rare; according to Bregmann it comes last in the list of peripheral arteries which show such sclerosis. In only 55 per cent. of the cases observed has the humeral artery been involved, in contrast with 94 per cent. for the cubital artery (lower brachial), 88 per cent. for the subclavian, 86 per cent. for the radial, and 71 per cent. for the axillary, to take only those of the upper limbs. Pieraccini and Devoto both emphasize the importance of prolonged muscular fatigue in these localized scleroses and believe that they constitute professional stigmata. That excessive work may produce vascular sclerosis was shown also by the observation of Marchand, who found the left femoral artery sclerosed in an individual with right hemiplegia. According to Erb another most important factor is cold. — Alice Hamilton.

## MENTAL

Industrial Hygiene. *Wade Wright.* Ment. Hyg., July, 1921, 5, No. 3, 497–498. — "All of the disabilities of man are not physical, and the mental disabilities must be of great concern to the worker for industrial health. One cannot consider the findings of the army psychiatrists that 70 per cent. of almost two million men had a mental age of less than fifteen years, even discounting it generously, without realizing that handicapped minds, like sick bodies, cause industrial wastage and a vast amount of sorrow and discontent.

"Little is known of ways to develop medical service in industry, but less is known of industrial psychiatry. For the psychiatrist there is a splendid job. It promises much in the way of aid in the difficult task of fitting men to the jobs they can best do and jobs to the men they need. Even with such an adjustment consummated, industrial discontent will still be found — but it should be a healthier unrest than we now know and that day a better one than this." — Stanley Cobb.

## NEUROMUSCULAR SYSTEM

Progressive Amyotrophy Resulting from Labor. *Giordano Vincenzo.* Abstracted as follows from Riforma med., 1920, No. 9, in Il Lavoro, March 31, 1921, 11, No. 11, 340–342. — A young man of 21 years was employed in a projectile factory in such a way that he was obliged to bend and extend his right arm continually, at the same time receiving very rapid and strong vibrations, while with his left arm he raised and lowered the handle of a pump. After nine months he began to lose strength in his right hand and after three months more, in his left hand. Stabbing pains, especially at night, became so severe that he could not sleep and at the end of eighteen months he was obliged to quit work. Vincenzo saw him two and a half years subsequent to his entrance in the factory and after six months' idleness. There was decided enlargement of the hands, with flattening of the thenar and hypothenar eminences, sinking of the interosseous spaces, great difficulty in flexion, especially in the right hand. He could not make a fist with his right hand. There was no disturbance of sensation, there was a marked reaction of degeneration of the median and ulnar nerves. Almost all the muscles of the right hand failed to react to the galvanic or to the faradic current. An X-ray examination showed bony atrophy and atrophy of the articular cartilages which corresponded to the Aran-Duchenne type of progressive amyotrophy, and the author believes that in this case the work done by the man was responsible, the strong and continuous

vibrations breaking the relation between the ganglion cells of the cord and the striated muscles. — Alice Hamilton.

## RESPIRATORY SYSTEM

Experimental Investigations on Calcium Therapy in Ursol Asthma. *Otto Mehl.* Zentralbl. f. Gewerbehyg., May, 1921, 9, No. 5, 98–101; June, 1921, 9, No. 6, 110–115. — This work was undertaken to provide an experimental basis for the calcium therapy as suggested by Dr. H. Curschmann. Work done by Curschmann and Gerdon on the nature of ursol asthma, which occurs in many persons handling dyed furs and skins, is here reviewed. Confirmatory experiments are cited by the author. Following sensitization with ursol-D and hydrogen peroxide, administered by intravenous or subcutaneous injection, anaphylactic shock was produced after eighteen days by intravenous injection, but not by subcutaneous injection or by the inhalation of the dye as dust. No shock could be produced following a single sensitization by inhalation of the dye.

Para-phenylenediamine produces dyspnea by vagus stimulation, with bronchial muscle spasm; leukocytic infiltration and exudation into the respiratory passages is set up. Calcium is a sedative for the whole nervous system, especially the peripheral motor neuron; it facilitates blood coagulation and reduces the permeability of the vessels. Calcium seems a hopeful antidote for the symptoms of anaphylaxis. From the various dosages and methods of administration the author chose subcutaneous injection of a 5 per cent. solution of calcium chloride, 0.2 gram per kilo of guinea-pig, given one to one and a half hours preceding the precipitation of shock. Guinea-pigs were sensitized by intravenous and subcutaneous injections with quinone-diimine. After eighteen days shock was precipitated. In no case where the calcium therapy preceded the shock dose were there any symptoms of anaphylaxis. There were areas of "calcium necrosis" at the sites of injection of the calcium chloride, but these healed spontaneously in a few days. Human therapy remains to be tried. It must be by some other route than injection. — E. L. Sevringhaus.

Some Further Communications on the Harmful Effects of Ursol among Workers in Furs. *Ritter.* München. med. Wchnschr., March 18, 1921, 68, No. 11, 333. — Dr. Curschmann's report in the *Münchener medizinische Wochenschrift* for February 18, 1921 leads Dr. Ritter to describe some cases of his own of the same nature, examples of which he sees every summer in patients suffering from the effect of ursol. These are workers in furs, and the cause of their illness is the use of ursol in the dyes employed. Some of the cases show typical asthma attacks, others complain of very persistent inflammatory conditions of the upper air passages. In both types, there are objective findings of inflammation of the mucous membranes, which make chemical lesions certain. Some patients have reported ulceration, but the writer has never observed a case. These cases must be differentiated from the ordinary asthma to which workers in skins are subject, and which is caused by dust and is purely mechanical and to be distinguished from the chemical (and mechanical) effects of ursol. The differential diagnosis is usually readily made. — G. E. Partridge.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

The Detection of Carbon Monoxide. *C. R. Hoover.* Jour. Indust. and Engin. Chem., Sept., 1921, 13, No. 9, 770–772. — Several forms of portable apparatus have been devised for the detection of carbon monoxide under industrial conditions. These have proved too elaborate, not sensitive enough or not specific for the gas, and in practical use mice or canaries have been found more trustworthy detectors. But these again have obvious disadvantages. As a result of work done in the Chemical Warfare Service on absorbents, a chemical carbon monoxide detector has been developed which answers the requirements very satisfactorily. It is sufficiently sensitive to detect in a few seconds smaller quantities of gas than are capable of causing harm to man or toxic symptoms in small animals. Concentrations of carbon monoxide as low as 0.005 per cent. can be detected. The greenish color developed is proportional to the amount of carbon monoxide present and by comparison with a color scale

gives a qualitative and an approximately quantitative determination. The detector substance "hoolamite" contains fuming sulphuric acid, iodine pentoxide and powdered pumice sealed in a glass tube. For use the tips are broken and the tube connected with a small hand syringe by which a measured volume of air, freed from interfering gases by passage through charcoal, can be passed through the tube. The color change occurs immediately but soon fades and should be read without delay. A more accurately graduated syringe has been designed for careful analyses and especially for laboratory tests.

The portable and sensitive detector described should, with the efficient carbon monoxide gas mask recently put on the market, materially increase the safety of work in mines and other places where dangerous concentrations of carbon monoxide are met. — H. S. Forbes.

Danger of Using Explosives in Confined Places. *C. L. Colburn.* Nat. Safety News, Aug., 1921, 4, No. 2, 32. — This is an account of a mine accident in which three of four operators lost their lives, poisoned by gases resulting from blasting in the raise. Upon investigation the powder used was discovered to have been 3 years old, and was probably incompletely detonated, giving off unusually large quantities of carbon monoxide and oxides of nitrogen. No ventilation had been provided to carry off the fumes.

The author enumerates the insidious properties of carbon monoxide and urges greater care against this gas on the part of all connected with mines. There are special apparatus now on the market for the detection of carbon monoxide which can be, and are by many companies, conveniently installed. Carbon monoxide is not only dangerous in mines, but also in garages and railroad tunnels and stations. Mr. Colburn refers the reader interested in this subject to the National Safety Council's pamphlet on *Commercial Explosives*; the U. S. Bureau of Mines Technical Paper No. 11, *The Use of Mice and Birds for Detecting Carbon Monoxide;* and Bulletin No. 8, *A Primer on Explosives for Metal Miners and Quarry-Men.* — M. Dent.

Accidental Death by Illuminating Gas under Ordinary Conditions of Work. *D'Alessio.* Abstracted as follows from Stampa Medica, March 15, 1921, in Il Lavoro, May 31, 1921, 12, No. 1, 15. — On the 24th of September, 1920, a man who was making connections in gas pipes in an excavation about 80 cm. deep in a street in Naples was obliged to quit work because of dizziness, difficulty in breathing, clouding of vision and a sense of illness. Following the rule of the company he was taken home and told not to come back till the next day. He felt better at first, ate his dinner as usual, then suddenly the symptoms returned with great severity and he was dead in two hours. Suspicions of poisoning were aroused and a careful autopsy with chemical tests was made. No change was noted except pulmonary congestion. The presence of carbon monoxide hemoglobin was demonstrated by the methods of Hoppe-Seyler, of Jolenisch, of Rubner, and of Katajama, and this although the examination was made four days after death. Spectroscopic examination was also positive. — Alice Hamilton.

The Injurious Action of Blast Furnace Gas. *Derdack.* Zentralbl. f Gewerbehyg., June, 1921, 9, No. 6, 109–110. — Furnace gases, both raw and purified, are probably injurious by virtue of the carbon monoxide content. Cyanogen, arsenic and hydrogen sulphide are highly improbable as the causes of poisoning by virtue of their low concentration and the fact that they are absent from some gases known practically to be injurious. Lewin's new book on *Carbon Monoxide Poisoning* is warmly recommended. — E. L. Sevringhaus.

New Researches on the Blood and the Blood-Forming Organs in Benzol Intoxication. *G. Fontana.* Abstracted as follows from Gior. d. clin. med., 1921, No. 3, in Il Lavoro, March 31, 1921, 11, No. 11, 329–331. — The action of benzol has thus far been studied chiefly with regard to the leukocytes. Fontana directed his attention to the red corpuscles and the platelets. Injecting eight guinea-pigs subcutaneously with a daily dose of 1 c.c. per kilogram and examining the blood every other day, he found that the animal succumbed on the fourth to the tenth day, and that at the moment of death the leukocytes and the granular erythrocytes (*emazie granulose*) had completely or almost completely disappeared from circulation. In one animal he provoked first, a leukocytosis and an increase of these erythrocytes by injecting nucleinate of sodium, and then, by the usual benzol injections, he reduced the leukocytes to 1400 and caused the granular

erythrocytes to disappear completely. Conversely, it was possible to cause a reappearance of these elements by administering nucleinate of sodium. The reduction of leukocytes affected the polymorphonuclears especially, and the last to disappear were the lymphocytes. In the most rapidly developing cases, however, this inversion of the leukocytic formula failed to appear. The effect on the reds was less marked, the hemoglobin was diminished by about one-tenth, the red cell counts fell in four days to 3,000,000. The granular red cells which have hitherto never been studied in benzol intoxication always diminished progressively and finally disappeared. Less constant results were obtained with the platelets, only about one-half of the animals showing a fairly well marked diminution. The volume of the spleen was diminished in all. The bone marrow was sometimes normal, sometimes gelatinous. Subseral ecchymoses were frequent and occasionally there were parenchymal hemorrhages. Microscopic examination of the femoral medulla showed scarcity of leukocytes, megakaryocytes among the red corpuscles and some polychromatophilia. There was increase of medullary fat, also congestion and small hemorrhages and sometimes atrophy. Smears from the spleen showed numerous white elements, chiefly mononuclear. The spleen was usually congested with subcapsular hemorrhages and atrophy of the malpighian follicles and sometimes a diffuse sclerosis. The lymphatic glands frequently showed small hemorrhages; the channels seemed empty of cells. There were only slight alterations in the liver, such as small hemorrhages and some fatty infiltration.

The author lays stress on the fact that individual animals react very differently to the same dose of benzol, some developing a very acute form of poisoning, others a slow form. He also notes that there does not seem to be a direct relation between the blood picture and the changes in the bone marrow, for he has found fairly extended areas of apparently normal marrow in animals in whose blood no leukocytes could be demonstrated. The total disappearance of the granular erythrocytes (immature forms) and the diminution of the mature forms show that, although the chief action of benzol is upon the leukocytes, the red elements also suffer. — Alice Hamilton.

Effect of Benzyl Benzoate on Leukocytes of Rabbit. *L. A. Emge* and *J. P. Jensen.* Abstracted as follows from Jour. Pharmacol. and Exper. Therap., June, 1921, 17, No. 5, 415, in Jour. Am. Med. Assn., July 9, 1921, 77, No. 2, 153. — "The experimental work done by Emge and Jensen showed that in rabbits a continuous administration of benzyl benzoate in small doses leads to a leukocytosis which in somewhat larger doses is accompanied by an increase in small mononuclear cells. This leukocytosis is transient and ultimately ends in a late mild leukopenia. In other words, the behavior of the blood picture suggests also that if it is due to some form of benzol or some intermediate product, such substance is of importance only after a sufficient amount of benzyl benzoate has accumulated in the system. In large but single doses of benzyl benzoate there is a tendency to change the even rise of the leukocytes into a broken curve of a diphasic character with a distinct depression of the polymorphonuclear element. Also here the mild and late leukopenia occurs. The changes in the blood curve are not dependent upon the method of the administration of the drug. In a very large, single, but not fatal dose the primary rise of the leukocytes does not occur necessarily but the blood curve assumes more of the leukopenia character, of the benzol curve. This leukopenia presents also here a diphasic polymorphonuclear picture. In the presence of latent or quiescent infections in rabbits larger doses produce an acute return of the disease. This is accompanied by sharp rises and sudden drops in the total as well as the small mononuclear white blood cells (actual lymphocytosis). A leukopenia was not observed when the recrudescence was very violent but when the recrudescence took a milder course there also was a suggestion of a late leukopenia. The flaring up of an infection in rabbits during benzyl benzoate therapy suggests a similarity to the action of benzol under similar circumstances. These data are in direct contradiction of those of Heller and Steinfield." — C. K. Drinker.

Industrial Mercury Poisoning. Il Lavoro, July 31, 1921, 12, No. 3, 85–86. — At the session of the Lombard Society of Sciences, April 22, Devoto presented two cases of mercurialism. The men were healthy, vigorous individuals who, after working for about three months in a dry battery plant where they used a solder containing mercury, developed symptoms of poisoning. The most interesting feature in

these cases was the almost complete identity of the early symptoms, of the course of the disease, and of its outcome. In both cases it began with a very slight stomatitis, followed by marked physical weakness, mental depression, tremor, headache, and dizziness. Mercury was detected in the urine of both, and in the blood there was a decided increase of red corpuscles, but the hemoglobin was diminished and in both there was present abundant granulation in the lymphocytes. — Alice Hamilton.

Earliest Positive Sign of Lead Absorption. U. S. Bur. Labor Statis., Month. Labor Rev., August, 1921, 13, No. 2, 405–408. — The basophile granulations (stippling) in the red blood cells, while not pathognomonic, are the earliest sign of lead poisoning. The fact that stippling occurs in malaria, pernicious anemia, and cancer does not detract from its value as a diagnostic sign in lead poisoning, since other morbid conditions can be ruled out by other clinical signs which are well known to every physician. In lead poisoning stippling appears before any other sign is manifest. Its appearance is intermittent, and it is the duty of the industrial physician to make frequent examinations of the blood of lead workers. — J. A. Key.

Observations on the Early Diagnosis of Lead Poisoning. *Böttrich.* Zentralbl. f. Gewerbehyg., June, 1921, 9, No. 6, 106–109. — Contrary to statements of Schoenfeld in the January number of the *Zentralblatt für Gewerbehygiene*, the author has found lead pallor and the lead line to be highly characteristic of lead poisoning. The lead line may be differentiated with certainty from confusing phenomena. The pallor should be considered highly suggestive in a lead worker. Basophilic degeneration is emphasized as a diagnostic sign of first importance. On theoretical grounds the author concludes that the lead must exert its toxic action in solution, not as circulating particles of metallic lead. — E. L. Sevringhaus.

Case of Aluminium Poisoning. *John Spofforth.* Lancet, June 18, 1921, 1, No. 25, 1301. — "I was recently called to see a man, aged 46, who was then employed at a firm of metalworkers. He was in a state of great exhaustion and suffering from very severe and persistent vomiting. The pulse was slow and irregular. I suspected metallic poisoning and later sent a specimen of his urine to ——, analytical chemists, who reported that it contained a large amount of aluminium, also of phosphates. The patient said that he had been dipping red-hot metal articles, contained in an aluminium holder, into concentrated nitric acid. Aluminium produces a rather slow intoxication. In this case it caused loss of memory, tremor, jerking movements and impaired co-ordination. There was also chronic constipation and incontinence of urine." — M. C. Shorley.

Magnesium Sulfate in Arsenic Poisoning. *Olga S. Hansen.* Abstracted as follows from Jour. Pharmacol., 1921, Vol. 17, 105–113, in Chem. Abstr., June 20, 1921, 15, No. 12, 1946. — "Definite conclusions cannot be drawn in regard to action of $MgSO_4$ in As poisoning but results may be summarized as follows: $MgSO_4$ has prolonged the average life of a series of 50 rabbits poisoned by As from 219 hours to 415 hours on the average, but cannot be said to have saved life in rabbits. $MgSo_4$ is toxic in large doses and to some extent in medium sized doses. There is a marked variation in individual susceptibility to As poisoning."

"Montanin" Poisoning. *Krausse.* Zentralbl. f. Gewerbehyg., July, 1921, 9, No. 7, 141–146. — A boy in a brewery drank "Montanin" by mistake and died within an hour. Montanin is a strong solution of hydrofluosilicic acid, used widely in breweries and distilleries for disinfecting all kinds of vessels. It is effective and is easily washed out. The chemistry, toxicology, and technology of this material is discussed and the postmortem findings given in some detail. — E. L. Sevringhaus.

The Ocular Menace of Wood Alcohol Poisoning. *S. Lewis Ziegler.* Jour. Am. Med. Assn., Oct. 8, 1921, 77, No. 15, 1160–1166. — The author reaches the following conclusions:

"1. Wood alcohol is the most deadly poison used in daily commerce.

"2. One teaspoonful has been known to cause blindness and 1 ounce to cause death.

"3. The port of entry may be through the mouth, nose or skin.

"4. Wood alcohol should be identified by Robinson's test.

"5. It is a protoplasmic poison possessing a selective affinity for the delicate nerve tissues of the eye.

"6. Its biochemistry is modified by oxidation, first to formaldehyd and then to formic acid, both of which are corrosive poisons.

"7. Formic acid is the end-product excreted by the kidneys.

"8. If formic acid is present in the urine, it will promptly reduce Fehling's solution, thus suggesting to the inexperienced a false diagnosis of diabetes.

"9. Van Slyke's test will reveal acidosis in the early stages and alkalosis later.

"10. Sudden blindness with vomiting and abdominal pain should always arouse suspicion of methyl alcohol poisoning; especially if diplopia or ptosis is associated.

"11. Papillitis, sector-like atrophy and sudden sclerosis of the nerve-head are equally typical fundus lesions.

"12. Symptoms of pituitary injury are most suggestive in pointing to this as the primary and fundamental lesion.

"13. Contracted fields and central or paracentral scotomas are usually present.

"14. Treatment should include early neutralization by alkalis, and elimination by lavage, emetics, diaphoretics and rapid oxidation, together with stimulation of the optic nerve by negative galvanism applied directly to the eye. Thyroid extract and pituitary extract may be indicated.

"15. The manufacture and sale of wood alcohol should be prohibited or regulated by law.

"16. If sales are permitted, safeguards and warnings should be required and the public instructed as to the great danger to vision and life.

"17. A special revenue tax with registered 'poison sales' would regulate and record its distribution and in cases of poisoning reveal the source.

"18. This tax should equalize the cost of denatured alcohol and methyl alcohol and thus remove the temptation to adulteration because of cheapness.

"19. All wines, whiskies, toilet articles and 'patent medicines' imported from foreign countries should be tested for wood alcohol before passing through the customs inspection.

"20. The name 'methanol' specifically designates this product and yet avoids the tempting suggestiveness of the word 'alcohol.'" — C. K. Drinker.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Tuberculosis in a Chemical Plant. *Rudolf Bachfeld.* Zentralbl. f. Gewerbehyg., June, 1921, 9, No. 6, 118–121; July, 1921, 9, No. 7, 146–149. — Statistical study of the cases of tuberculosis among the employees of a dye works for six years previous to the war and for four years during the war leads to the conclusion that close association with the chemical materials tends to increase the number of cases of tuberculosis, the fatality of the disease, and the loss of working days due to illness which is later recovered from. Other employees in the same plant, similarly fed but not associated with the chemicals, form the basis for comparison. The number of cases of tuberculosis is too small for conclusive proof or accurate ratios. Acute poisoning with aromatic hydrocarbons and derivatives does not seem to play any rôle in the unfavorable action of such employment. — E. L. Sevringhaus.

Syphilis in Glass Blowers. *Bajla.* Abstracted from the Bollettino dell' Ordine dei Medici della Provincia di Milano, June, 1920, in Il Lavoro, July 31, 1921, 12, No. 3, 83–85. — This is the report of an examination of glass blowers in Milan, undertaken in consequence of the discovery of a case of syphilis in an employee. The victim was a boy of 14 years employed in a large glass works and suffering from primary lesion of the upper lip. The municipal department of hygiene ordered an examination of all the glass blowers, with the result that seven syphilitics were discovered all with lesions in the mouth. This was in 1908, and soon after that regulations were passed by the municipal government requiring medical inspection of workmen in glass factories at least once a week, daily disinfection by flame of the portion of the blower's pipe which comes in contact with his mouth, prohibition of the common drinking cup, compulsory notification of cases of syphilis developing among the workmen, and also of cases of pulmonary tuberculosis. The improvement following this legislation has been excellent. During 1908 thirteen

cases of syphilis in glass blowers were discovered in one establishment, but not a single case since then. Milan has the credit of being the first city to attack this particular danger in industry, but France has since followed her example although the French law is not so strict. — Alice Hamilton.

Industrial Application of Army and Navy Venereal Disease Records. *R. H. Everett* and *M. A. Clark*. Am. Jour. Pub. Health, Sept., 1921, 11, No. 9, 829–833. — Venereal diseases are a much greater handicap in industry than existing industrial statistics indicate. This inference may properly be drawn from the 1920 reports of absences from duty in the army and navy. In the former more than 13 per cent., and in the latter 15 per cent., of all absences were from venereal diseases.

The author advocates a thorough-going scientific study of the many-sided problem of the relation of venereal diseases to industry. He recommends as the result of an interrogatory to sixty-three industrial physicians and surgeons four lines of approach: educational work among owners, directors, managers, and executives; more comprehensive questionnaires; an investigation of conditions in one thoroughly organized corporation; and further development of medical service in industry. — H. F. Smyth.

Malignant Pustule with Multiple Lesions. *R. T. Grant*. Lancet, Sept. 17, 1921, 2, No. 12, 606–607. — A butcher skinned a bullock, which the following day was found to have died from anthrax. The man washed his arms and cleansed his underclothes in disinfectants, but not his outer clothing. Eight days later a small pimple appeared on the back of the right hand between the thumb and first finger. The sore was very itchy and irritable and discharged a thin clear fluid. Three days after its appearance it was diagnosed as a malignant pustule. A smaller pustule, unobserved by the patient, was found on the left forearm surrounded by a zone of edema about 5 inches in diameter. Smears from both pustules showed anthracoid organisms, and a guinea-pig inoculated from the pustule died in thirty-six hours, showing the extreme virulence of the bacilli present. The foci were excised and two subcutaneous injections of Sclavo's serum given. The patient made an uninterrupted recovery. — R. Prosser White.

Case of Human Anthrax in Buganda Kingdom. *W. L. Peacock* and *H. L. Duke*. Abstracted as follows from Lancet, Aug. 13, 1921, 2, No. 7, 332, in Jour. Am. Med. Assn., Sept. 10, 1921, 77, No. 11, 891. — "A man whose work had nothing to do with hides or cattle, had cut up some of the flesh of a bullock. Three days later he noticed a small papule on his cheek which he scratched, and it had gone on increasing in size from that time up to his admission to hospital some six days later. On admission the pustule was at once excised and the wound painted with pure phenol, partly closed by stitches, and a wet phenol dressing applied. A smear examined immediately after the excision showed typical anthrax bacilli in pure culture." — C. K. Drinker.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Carcinoma Cutis in an Anthracene Factory. *W. J. O'Donovan*. Brit. Jour. Dermat. and Syph., 1921, Vol. 33, p. 291. — The writer prefaces his paper by giving references to three recent investigations where true, squamous, horny carcinomata were experimentally caused, in animals, by the systematic application of tar. In 1915 Yamagiwa and Ichikawa described successes, and in 1918 Tsutsui reported the production of hyperkeratosis, papillomatous growth and carcinoma in mice. The latest is this year's experimental work by J. Fiebiger and Bang.

Dr. O'Donovan illustrates the lesions of the three cases he describes. All the men were engaged in manipulating the crude anthracene "cake" brought to the factory. It was unloaded by hand and broken down, and when further purified formed an intermediate product in the making of alizarin dye.

Case 1. — Aged 62. During the last five years he had been employed in unloading boxes and sacks containing the raw "cake." His face was deeply bronzed, the forearms brown, but the covered skin was white. On the forearms were many small telangiectases and follicular

keratoses. The back of the right wrist showed a raised flat ulcerating tumor which started as a small wart six months previously. The growth was removed.

CASE 2. — The second man, aged 53, had worked for thirty years in the factory at grinding and loading, and he also looked after the centrifuges in which the anthracene cake was whizzed. During the last three months he noticed a pimple on the center of the right cheek, which rapidly grew in size, forming a button-like, raised growth the size of a half penny. It entirely disappeared under treatment by radium.

CASE 3. — The third man, aged 59, had been a foreman for twenty years in the purifying room. He had noticed an ulcer above the right wrist joint for four years. It had enlarged more rapidly during the last six months, and when examined was 3 inches by 2 inches, with a hard, rolled, raised border. There were no enlarged regional glands. The ulcer was excised and the wound skin grafted.

Each of these growths proved to be microscopically a squamous and horny-celled cancer. At the factory there was no recollection of any previous cases of persons employed in this industry needing hospital treatment for similar lesions. Three cases of carcinoma, occurring in four months in a plant employing about twenty-five men, Dr. O'Donovan considers "a heavy incidence of a grave industrial disease." He concludes as follows:

"Elderly anthracene workers are liable to carcinomata of the skin similar to those found in sweeps, tar, creosote and paraffin workers.

"These growths are squamous and horny-celled carcinomata; metastases have not been found.

"Unlike tar cases a multiplicity of growths in any one patient was not met with. Four years was the longest and three months the shortest duration of the growths.

"Minor lesions, acne, keratoses, telangiectases and pigmentation, are common features in workers in the plant.

"A plant may run for 35 years before a carcinoma case develops.

"The handling of purified anthracene does not appear to have the industrial hazard attributed to the handling of anthracene cake." — R. Prosser White.

DERMATITIS CAUSED BY BITTER ORANGE. *F. Anderson Murray.* Brit. Med. Jour., May 21, 1921, No. 3151, 739. — "Occupational dermatitis due to the handling of certain flowers and plants is well known, but cases are not very common, so that they may be rather difficult to recognize. In Sequeira's *Diseases of the Skin* is given a list of over forty plants which are known to have caused dermatitis. Among them is the bitter orange, and several cases of this form of dermatitis recently came under my notice among girls engaged in peeling bitter oranges in a jam factory.

"The most marked case was that of a girl, aged 25, who suffered from a very acute dermatitis of the fingers, hands, and forearms, and also of the face. There was intense erythema and much swelling, especially of the hands and forearms, the parts most exposed to the juice. There were numerous small vesicles, a little larger than the size of a pin-head, all over the affected areas. I put the patient to bed for one week and applied a lotion of zinc carbonate, pulverized calamine and aqua calcis, which proved very effective, the inflammation entirely disappearing after ten days. Idiosyncrasy evidently plays a considerable part in the condition, as in spite of all precautions the girl in question had ultimately to give up the work." — M. C. Shorley.

RADIUM TREATMENT OF ROENTGEN DERMATITIS. *J. Bergonié.* Abstracted as follows from Médecine, June, 1921, 2, No. 9, 675, in Jour. Am. Med. Assn., July 30, 1921, 77, No. 5, 409. — "Bergonié relates that he has recently examined three roentgenologists who have had professional radiodermatitis benefited by application of radium. One of these physicians has had one finger amputated and amputation of another finger of the right hand was being considered. Another has already had four operations on the hands; the general condition was bad and the pains at times unbearable. Under exposure to radium, one of the physicians seems completely cured, all symptoms having subsided. The contemplated operation on the second has been abandoned; there is no more pain, and the stiff joints have become supple. The condition has been notably improved in the third; there is now scarcely any pain. The curietherapy has thus proved its efficacy for these roentgen lesions except the deep eschars involving the bone, with inadequate circulation and loss of muscle tissue. It seems to aggravate this class of lesions as in the third case mentioned. Most of this physician's lesions im-

proved, but the deep eschars seemed to be whipped up to a more rapid course." — C. K. Drinker.

Diseases of the Ear in Railway Employees Working at a High Altitude. *A. Ciampolini.* Abstracted as follows from the Bollettino delle malattie dell' orecchio, della gola e del naso, Vol. 34, No. 9, in Il Lavoro, March 31, 1921, 11, No. 11, 331–335. — The men who formed the subject of this study were employed on the railways crossing the Appennines between Pistoia and Bologna and between Florence and Faenza. These men are exposed to sudden changes of temperature and of air pressure. The author found affections of the ear in 40 per cent., the affection having its origin in the pharyngeal cavity. In four cases with lesions of the internal ear he believed that here also the initial stage was probably a catarrhal pharyngitis, then a salpingitis with extension to the middle ear and finally to the bones of the labyrinth. Fifteen of the men had had a marked reduction of hearing; so much so that they were obliged to give up their work. The age of two-thirds of the men was between 40 and 50 years, and they had worked on the railways from twenty to thirty years. The other third were under 40 years and had worked from six to twenty years. In addition to the variations in temperature and pressure, other disadvantages on these lines consist in an increase in the noise, which is also of a higher pitch, because of the high pressure engines used, and because of the frequency of tunnels. — Alice Hamilton.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Do Safety Drives Pay? *K. P. Babcock.* Nat. Safety News, Sept., 1921, 4, No. 3, 32–33. — The two weeks' safety drive of the Gilbert and Barker Manufacturing Company, an outline of which is given in this article, was a powerful stimulant for accident prevention among the employees, and resulted in many unexpected discoveries which led to the replacing or repairing of a number of machines and tools. During the drive, the safety committee received 153 safety recommendations independent of those made by the workman's safety committees, only three of which were considered impracticable. The company ascribes much of the success attained in its safety drive to the following practices:

"(*a*) Educate the employees thoroughly in the work through constant personal contact and demonstrations of actual results from improper acts. . . .

"(*b*) Do not waste time and money on safety drives and other expensive publicity until the employees are fully conversant with what you are attempting to do and show a willingness to co-operate with you.

"(*c*) Get down to brass tacks on each subject you attack and stay there until it is properly rounded out.

"(*d*) Make each endeavor count from its own weight; that is, make one injury prevent another, both to the injured and others. Build guards so they will be attractive, effective and in no way an obstruction to millwrights, beltmen or machine operators. . . .

"(*e*) Do not hurry, worry, or get angry. . . . Make each employee feel you are a real fellow; one whom they can tell their troubles to and receive help from. Treat all confidences seriously and sympathetically when necessary.

"(*f*) Keep the management perfectly informed concerning the progress of the work. . . .

"(*g*) Whenever possible order machines already equipped with guards.

"(*h*) Build guards as a part of the machine. . . . Never neglect to get the machine operator to tell you how he thinks the guards should be built. . . . Through this course an employee thinks more of the guard and will not only use it constantly, but will maintain it. He will also feel proud of its construction, and boast of its value, which greatly aids the work of machine guarding." — M. C. Shorley.

Safety Work of the Federal Government. *Edward B. Rosa* and *Charles E. Oakes.* Safety Engin., July, 1921, 42, No. 1, 10–14. — This is a brief history of the work of the federal government in scientific and industrial research to develop apparatus, methods and processes usable in industry, which will result in the increased health and safety of the nation.

*Bureau of Mines.* — "Some of the earliest work of this bureau was concerned with the determination of the effect of carbon monoxide on men. Leading up to the development of the Gibbs mine-rescue apparatus, considerable research work was done on the effect of various percentages of carbon dioxide and of a de-

ficiency of oxygen on the human system. Similar work with poisonous gases was necessary in developing commercial and army gas masks. Other research work involving gases was the determination of limits of explosive mixtures of methane, gasoline vapors, and acetylene in air; the volume and composition of exhaust gases of gasoline mine locomotives and of automobiles and trucks; and the development of portable instruments for the determination of carbon monoxide, carbon dioxide and oxygen in mine air. . . . Complete sets of rules and regulations for metal mines, and for the use of electricity in bituminous coal mines, have been drawn up, and both have been used as the basis of state laws relative to these subjects."

*Public Health Service.* — "The Public Health Service has conducted and is now conducting extensive researches in the field of sanitation and health insofar as it concerns industry, including the efficiency of ventilating systems, air conditions, dermatic hazards from oil and other materials used in the operation of machinery, lead poisoning in the pottery industry, hygienic practices in foundries, and industrial fatigue."

*Interstate Commerce Commission.* — This organization requires carriers to report any accident resulting in death on or about engines, trains, or cars, a small percentage of which are investigated by the Bureau of Safety. The Commission also makes periodic inspections of locomotives and can order out of service any found defective.

*Bureau of Standards.* — In a great many cases the researches of the Bureau of Standards have led to improvements in design and practice for the express purpose of preventing accidents.

"An investigation of methods and apparatus for using the magnetic properties of materials as an indication of the quality and mechanical properties has been under way for several years. . . . Other researches toward the standardization of safety practices, which may be cited as examples, are: an investigation of glasses for protecting the eyes from injurious radiation encountered in industrial pursuits, such as are welding, . . . tests on the fire-resistive properties of structural materials, and an investigation of the effectiveness of elevator interlocks."

*Bureau of Labor Statistics.* — This bureau has collected and published labor laws "for the information of manufacturers and the public," and has given "considerable attention to the standardization of accident reports."

The authors conclude with an account of the hearty co-operation that exists between government bureaus, state authorities, technical societies, and manufacturers' organizations; of the expenditures of the federal and state governments "for accident prevention and sanitation work in all industries of the country;" and of the efforts to standardize the work. — M. Dent.

Why Should We Not Prevent Accidents. *S. Dana Hubbard.* Safety Engin., July, 1921, 42, No. 1, 24–26. — Accident statistics, such as that in the United States 35,000 workers are killed and 2,000,000 injured annually through accidents, are reviewed, and a plea is made for more care, ceaseless propaganda, and untiring efforts to reduce these frightful figures. Dr. Hubbard classifies the causes of accidents into the human element in industry, the mechanical or physical, and the conditions of environment. Ninety per cent. of all accidents are caused by the human element, and it is, therefore, for that element that propaganda should be used. But in keeping machinery safe and efficient, and in having the factory as far as possible an ideal place to work in, the human element will not play so important a part as hitherto.

There are social reasons of pure humanitarianism which demand accident safeguarding, and economic reasons of the effect on the morale of workers when an accident occurs and of the monetary loss when a trained man is injured and must be replaced by an unskilled workman. — M. Dent.

Safety Where the Bessemer Blows. *Louis Resnick.* Nat. Safety News, Aug., 1921, 4, No. 2, 3–8. — This is an enthusiastic account of the very real work done by the United States Steel Corporation and its subsidiary companies. The United States Steel Corporation was a pioneer in safety and is still one of the most efficient examples of careful safety work. Its policy is "first, to lock the stable before the horse is stolen; second, that there is real safety discipline in the steel corporation's properties; third, that the cost of any accident prevention device or activity is the last thing to be considered, if it is considered at all. . . ."

A brief outline of its policy is as follows: "the steel corporation has a general plan of safety organization for its subsidiary com-

panies, and the companies have a general plan for their respective plants; but each company and each plant is allowed to work out its own detail safety problems in its own way, and in much the same manner every superintendent and every foreman is given free rein in safety work so long as he gets results. The safety bureau of each company acts as a clearing house of information for its constituent plants, and the bureau of safety, sanitation and welfare of the corporation is the clearing house for the entire family of the subsidiary companies operating several hundred plants and employing a quarter million men and women." — M. C. Shorley.

The Group "Poisonous Substances and Gases" in the Accident Statistics of the Trades Unions. *Rheinfels.* Zentralbl. f. Gewerbehyg., June, 1921, 9, No. 6, 115–118. — A discussion of the proper definition of the term poison and the classification of accidents more accurately as to cause. — E. L. Sevringhaus.

Engineering Revision — The Engineer's Part in Safety. *C. P. Tolman.* Nat. Safety News, July, 1921, 4, No. 1, 10–12. — Mr. Tolman states that an annual waste of a billion dollars a year occurs from industrial accidents. In his article he suggests safety methods for better lighting and guarding of machinery, and for better ventilation of buildings. The employee who is interested in his work takes chances in order to hurry that work up and produce his finished article. The safety engineer should "make it easiest and most effective" for him to do his job in the right way and thus eliminate needless risks. Statistics are given as to the money returns on various guards for presses and saws which result from the possibility of speeding up production without risk. — M. Dent.

Industrial Accident Frequency in Wisconsin, 1915 to 1920. *A. J. Altmeyer.* U. S. Bur. Labor Statis., Month. Labor Rev., June, 1921, 12, No. 6, 1117–1121. — "Most states which have workmen's compensation laws collect statistics on industrial accidents, but no state calculates accident frequency rates or accident severity rates for the state as a whole, to say nothing about the various industries. It would be of great value if this could be done, since it would place safety work on a more scientific basis." — R. B. Crain.

Statistical Study of Electrical Accidents. *Hans Jaeger.* Zentralbl. f. Gewerbehyg., Aug., 1921, 9, No. 8, 153–168. — Swiss statistics for the period 1904–1920 are analyzed and discussed at length. Nine hundred and sixty-nine cases of electrical accidents are reported. The annual number is increasing, but there is a decrease relative to the increasing extent of electric installations. Increasing use of safety devices, official supervision, and education are held responsible for the improvement. The excessive accident rate in the summer months is attributed to the greater perspiration and greater fatigue, with carelessness following.

Railway accidents are one-fifth of the total, the other four-fifths are industrial. The increase is in this latter group. The number of accidents among the unskilled group of workers indicates that training and warning must be made very general to be effective. High and low tension lines are both extremely dangerous, with high mortality for accidents where more than 100-volt lines are involved.— E. L. Sevringhaus.

Protection and the Eye. Safety Engin., July, 1921, 42, No. 1, 42–44. — 1. Chipping, calking, and hot riveting require goggles with rigid non-adjustable bridge or adjustable metallic bridge, side shields, and lens able to withstand a blow from a "spherical steel ball weighing at least one-half ounce and dropped from a height of 21 inches at least ten times" onto the surface of the lens.

2. For scaling and grinding of metals, stone dressing and sand paper or emery cloth wood dressing, any sort of goggles may be worn but goggles with side shields are advisable, and the lens should be able to withstand a blow such as flying chips from an emery wheel would give.

3. "Babbitting, casting of hot metal, and dipping in hot metals require protection from splashing and small explosions caused by hot metal coming in contact with steam. Goggles of any style may be used depending upon the particular hazard."

4. When handling acids and caustics eyecup goggles, hoods, and face masks will prevent the fumes and liquids from entering the eyes.

5. For sandblasting, a hood which will entirely cover the head and reach below the neck is necessary.

6. For furnace work and heat treatment goggles with tinted lenses should be worn as a protection against glare.

7. In oxyacetylene welding and furnace work the eyes must be protected from harmful light rays, heat and flying particles. "The lens of the goggle, shield, helmet or face mask used has been fairly well standardized among manufacturers, and any reputable goggle manufacturer can furnish the proper lens, knowing the conditions under which it is to be used."

8. In electric arc welding the radiation is so intense that serious burning of the skin as well as injuries to the eye may result. Helmet and shield are recommended.

9. A light-weight goggle without side shields is all that is necessary for machining of hard or brittle metals. — M. Dent.

The Relative Safety of Brass, Copper, and Steel Gauzes in Miners' Flame Safety-Lamps. *L. C. Ilsley* and *A. B. Hooker*. U. S. Bur. Mines, Tech. Paper 228, 1921, pp. 39. — The following conclusions are reached: "The behavior of the different gauze fabrics has in a general way checked the results obtained by Belgian investigators. When the differences in the materials tested, together with possible differences in the test conditions, are considered, it is remarkable that the results in many tests follow so closely the conclusions of investigators abroad.

"For conditions of high temperature, steel proved superior to either brass or copper. For low temperatures, the advantage of steel over brass or copper is little. Brass or copper might be preferred by some, although one who knows the insecurity of such gauzes at high temperature might be unwilling to trust them, even though the probability of high temperatures was remote.

"Brass proved more satisfactory than copper, but the brass gauzes tested had a high proportion of copper and therefore may have given much better results than would have been obtained with some other brass.

"In conducting the tests of the gauze fabrics under various possible conditions of service certain points were brought out forcibly. The least safe of all the lamps tested is the single-gauze unbonneted lamp of the Davy type. In fact, compared with a bonneted lamp of modern design it should not be classified as a safety lamp. The condemnation of the Davy lamp as a safety device for present-day conditions does not belittle the great work done by Davy, for almost every modern lamp uses principles he advocated.

"The double-gauze unbonneted lamp is somewhat safer than a single-gauze lamp, but is not dependable in high-velocity air mixtures.

"The single-gauze bonneted lamp proved safer than either type of unbonneted lamp; the omission of a gauze is more than offset by the bonnet.

"The safest lamp tested was the double-gauze bonneted lamp, which has the protective features of the single-gauze bonneted lamp and the added safety of another gauze in case either gauze of a pair should become damaged. In this investigation the Hailwood combustion-tube lamp was not tested, but previous tests by the bureau have shown it to be as safe as a double-gauze bonneted lamp of the Koehler type.

"The chief object of the investigation was to determine whether the gauze specifications of Schedule 7 needed revision. The results indicate that present specifications, though perhaps not detailed enough rest on a sound foundation, and that a lamp meeting these requirements would have a high standard of safety. It may later be deemed best to permit the use of brass gauze in bonneted lamps, but until the subject is investigated further the schedule should not be changed in that respect. A requirement that only bonneted lamps be admitted as permissible for use in gaseous mines could well be added as a step toward greater safety.

"The possibility of using monel metal or nickel for flame-lamp gauze has been suggested, as these materials have a higher melting point than steel, have about the same heat conductivity, and resist oxidation at atmospheric and at high temperatures. These materials should be investigated." — M. Dent.

Gas Mask for Carbon Monoxide Perfected. Safety Engin., July, 1921, 42, No. 1, 51–52. — A public demonstration of the gas mask for protection against carbon monoxide, manufactured by the Mines Safety Appliances Company, Pittsburgh, and in which is used the chemical mixture Hopcalite, developed by the U. S. Bureau of Mines and Chemical Warfare Service, U. S. Army, was given May 26 in the special smoke room of the U. S. Bureau of Mines, Pittsburgh. In this test two men entered the smoke room, which contained 1 per cent. of carbon monoxide gas in the air. One of the men carried a canary bird into the room to indicate to the observers the poisonous nature

of the atmosphere. The canary bird collapsed in forty-five seconds and was removed. The wearers of the masks remained in the atmosphere for thirty minutes doing vigorous work part of the time, and experienced no ill effects whatsoever from the poisonous carbon monoxide gas. — R. M. Thomson.

Explosions in Air Compressors. Safety Engin., June, 1921, 41, No. 6, 285. The elimination of heat generated in air compressors is largely accomplished by lubrication and water cooling jackets. The danger from internal explosions are: (1) oil vapor; (2) carbonized lubricating oil, which deposits and prevents valves from closing.

Carbon accumulation may be lessened by selecting proper oil, the feeding of oil being kept down to a minimum for safety; and by thoroughly cleaning the compressor apparatus by disconnecting the oil and feeding soapy water or lye solution for a time. No inflammables should be used in cleaning. R. M. Thomson.

Acetylene Generator Precautions. Safety Engin., June, 1921, 41, No. 6, 271. This brief article gives an account of an explosion of an acetylene generator through careless inspection of the equipment before charging. — R. M. Thomson.

Safe Practices on Metal Working Machinery. *W. Dean Keefer.* Nat. Safety News, Aug., 1921, 4, No. 2, 13-14. — The guards described in this article can all be made in the plant, and are for lathes, turret lathes, automatic screw machines, drill presses, milling machines, planers, and boring mills.

The important feature of safety lathe dogs is the elimination of the protruding set screw, which may be done by designing the dogs without protruding parts, or by inserting countersunk set screws. The best practice for overcoming the hazard of revolving stocks on turret lathes and automatic screw machines is to install "sections of piping through which the bar stock is fed to the machine," and which can be made in short lengths, so that they will telescope and the guard can be shortened as the stock is used up.

To guard against flying chips, a shield should be used on lathes and shapers. "A satisfactory shield for a lathe may be cheaply made of fine wire mesh. Take a piece of mesh about 8 to 12 inches square and cut a hole through it near one edge; then by fitting the hole over tool post, the shield may be bent in any desired position to stop chips." On milling machines a guard should be provided for the cutter which is a frequent cause of accident. Openings under planer tables, where workmen can conveniently throw their hammers, wrenches, etc., should never be left. Sheet iron can be used to cover the openings between the planer ways, or a solid web installed between the runways.

In order to avoid minor accidents which frequently occur while workmen are sharpening tools, a tool room should be installed in charge of a man skilled in sharpening machine tools. Besides the lessening of injuries there will be a considerable saving in tool steel which inexperienced workmen often overheat and ruin the temper of.

Readers who are interested in a more detailed account will find it in the National Safety Council's Pamphlet on *Machine Shop Machinery.* M. Dent.

Safety Standards for Trench Construction. *John R. Brownell.* Nat. Safety News, Aug., 1921, 4, No. 2, 15-16. — California is the only state which has definite requirements for safe construction of trenches. A résumé of its principal points is as follows:

1. "All materials used for sheeting and sheet-piling shall be in good condition, and all timbers used shall be sound, straight, free from cracks, shakes and large or loose knots, and of the required dimensions throughout.

2. "Where running material is encountered, the sides of all trenches four feet or more in depth shall be secured by the use of sheet-piling and suitable braces, as defined in these orders.

3. "Where trench is between four feet and seven feet in depth, wooden sheet-piling shall be not less than two inches in thickness. . . .

4. "The sides of all trenches in hard, compact material which are five feet or more in depth and over eight feet in length shall be securely held by shoring and bracing. . . .

5. "All trenches of over eight feet in length and five feet or more in depth in hard, compact material shall be braced at intervals not exceeding eight feet with two inch by six inch planks, or heavier material, placed vertically in the trench opposite each other against the walls. These braces shall, if possible, extend to the bottom of the trench. . . .

6. "The braces in trenches shall be supported by screw jacks or by timbers placed normal to both braces, cleated, and rigidly screwed or wedged.

7. "The number of horizontal strut braces, either screw jacks or timbers, required for each pair of vertical braces shall be determined by the number of zones of four feet each into which the depth of trench may be divided. One horizontal brace shall be required for each of these zones. . . .

8. "The bracing and shoring of trenches must be carried along with the excavation. . . .

9. "Stringers shall be not less in strength than two by six inch clear timber.

10. "Trenches in saturated, filled or unstable material (not running material) shall be sheeted to an extent adequate to hold the material in place. . . .

11. "Excavated material shall not be placed nearer than one foot to the edge of the trench.

12. "All trenches five feet or more in depth shall be supplied with at least one ladder for each 200 feet in length or fraction thereof, which ladder shall extend from the bottom of the trench to at least two feet above the top." — M. Dent.

Increasing the Safety from Accident and Fire in the Wood Working Industries. *P. M. Grempe.* Zentralbl. f. Gewerbehyg., July, 1921, 9, No. 7, 151–152. — Safety from accident and fire is being attained in many plants by the use of lighting circuits operating at 12 to 20 volts, the current being derived from special transformers connected with the higher voltage lines and specially insulated against short circuits. — E. L. Sevringhaus.

Safety Devices for Automatic Barrel Washers. *Behr.* Zentralbl. f. Gewerbehyg., June, 1921, 9, No. 6, 127–128. — The author gives diagrams and a description of moving apparatus arranged to prevent workmen from getting in contact with the moving parts of machinery for washing barrels. — E. L. Sevringhaus.

The Question of the Fall of Elevators, with Special Reference to Safety Brakes. *E. Dorn.* Zentralbl. f. Gewerbehyg., July, 1921, 9, No. 7, 129–141. — This is a technical discussion of the elements of danger in elevator construction, with special reference to the common brake devices. Diagrams and explanations of improved braking apparatus are included. — E. L. Sevringhaus.

Finger Guard for Eccentric Presses. *M. Eckstein.* Zentralbl. f. Gewerbehyg., June, 1921, 9, No. 6, 125–127. — This article contains diagrams and description of the construction and operation of a guard for eccentric stamping presses, which is entirely automatic in action, does not hinder work, and which stops the press if anything is in danger of injury from the action of the press. — E. L. Sevringhaus.

## HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

Electrical Hazards and their Safeguarding. *H. S. Balliet.* Safety Engin., June, 1921, 41, No. 6, 272–274. — This paper was abstracted from the original address as delivered by the American Society of Safety Engineers, so as to contain the essential safety matter, and deals with the general practices of the New York Central Railroad in grounding high tension lines both underground and overhead, the safeguarding of employees by the use of screens, etc., and the safeguarding of equipment by mechanical devices. The work of transmission department and signal department employees is definitely laid out as to what is required of each in the operation and maintenance of the equipment, and the wearing of rubber gloves and the using of other protective appliances are insisted upon. — R. M. Thomson.

Safety Features on High Voltage Transmission Lines. *C. O. von Dannenberg.* Safety Engin., July, 1921, 42, No. 1, 15–17. — This is a brief review of certain features in high voltage electrical installations, to which it is believed particular consideration and attention should be given in order to obtain a maximum degree of protection and safety. The points under consideration are referred to in a general way: *viz.*, line structures; line disconnecting switches; grounding; telephone equipment for high ten-

sion lines; and working on live lines. As a general rule it may be said that fewer accidents result in the operation of high voltage than in low voltage equipment. This statement is somewhat misleading for the following reasons: (1) The number of persons handling high voltage equipment is much smaller, as low voltage is in far greater use. (2) High voltage equipment is much less accessible and is usually placed out of reach. (3) The persons handling high voltage equipment are usually of greater intelligence. (4) The knowledge that a high voltage exists tends to lead to greater care in handling equipment. — R. M. Thomson.

## WOMEN AND CHILDREN IN INDUSTRY

Work and Fatigue in the Puerperal State. *Pericle Carlini.* Abstracted as follows from Annali di Ostetricia e Ginecologia, 1920, in Il Lavoro, April 30, 1921, 11, No. 12, 360–361. — The author used the dynamometer and the ergograph of Mosso to determine the capacity for work of healthy women at various periods of pregnancy. He concludes that the capacity for work of pregnant women begins to diminish in the sixth month and decreases in geometrical progression up to parturition, after which it increases, reaching the normal toward the end of the third month. The daily record shows a slow rise of output reaching its maximum during the third hour, being sustained for only a short time, while the midday rest is not followed by a second rise but by a progressive fall. Twenty-six women tested with the ergograph showed a diminution of muscular strength from the second or third month of pregnancy, a return to almost normal limits from the fourth to the sixth months, and then a decided drop lasting through the first month of the puerperium with a return to normal limits in the second month of the puerperium in women who were not suckling their children, and in the fifth month in women who were suckling. — Alice Hamilton.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Labor Camp Sanitation — A Basis for Education and Citizenship. *R. Justin Miller.* Am. Jour. Pub. Health, Aug., 1921, 11, No. 8, 697–702. — This article describes the filthy conditions prevalent in labor camps in California prior to 1913 when the first Labor Camp Sanitation Act was passed by the California legislature. The act, a model of simplicity and brevity, requires the following:

"1. Bunkhouses or other sleeping quarters sufficient to protect the occupants from the elements, kept cleanly, and located on clean and properly situated camp grounds.

"2. Beds or bunks.

"3. Screened and otherwise sanitary dining quarters and rooms for storage and preparation of food.

"4. Adequate and sanitary toilet facilities.

"5. Sanitary facilities for garbage disposal.

"6. Adequate bathing facilities.

"7. Appointment of 'a responsible person to assist in keeping the camp clean.' "

The inspection, advisory, and educational work of the Commission of Immigration and Housing, which since 1915 has had full control of the enforcement of the act, is described. As a result of this act and its enforcement, labor camps in California have proved a new and substantial basis for citizenship on the part of a class heretofore scarcely considered in the problem of government. With camps having proper sanitation the lower type of labor and the agitator are eliminated. Camps of today aid the inspector by giving notice of bad sanitary conditions. — H. F. Smyth.

A Year's Developments in the Science of Industrial Lighting. Safety Engin., Aug., 1921, 42, No. 2, 54–57. — An outline of a report presented at the Forty-Fourth Annual Convention at Chicago, May 31–June 3, 1921, by the Lighting Sales Bureau of the National Electric Light Association. A few figures and graphs support the reviewer's claim of increased production resulting from the installation of modern lighting in factories, this increase being due to lower accident rate, lessened eye-fatigue, improved health and morale, lessening of supervision and labor turnover, and reduction of unit cost. — Philip Drinker.

Light Much Neglected in Efficiency Promotion. *S. E. Doane.* Nation's Health, Aug. 15, 1921, 3, No. 8, 440–442. — The eye is much abused in industry, in part because its adaptations, being unconscious, are not considered, and it was only on account of the demands made by the war that illuminating became a serious problem in efficiency.

Recent statistics of insurance companies attribute 15 per cent. of all accidents to poor lighting, and to the same cause three hundred and fifty millions of dollars of wastage annually in the United States is charged.

There are sometimes peculiar and unobserved effects due to lighting, as in the case of a drill, in the working of which accidents were constantly occurring. The cause was traced to a slight regular reflection of light. Sometimes the effect of bad light may be very pronounced, and at the same time entirely unperceived by the worker. Glare will often produce a mental state unfavorable to work. All lamps should be shielded by diffusing glassware or other medium. Color quality of light, its direction and its uniformity are important considerations.

The work of the Illuminating Engineering Society is mentioned, and the transactions of the society are recommended as a source of information on the subject of lighting.

The article contains four diagrams showing effects of increase of intensity of light on acuity, speed of discrimination, and adjustment for distances. — G. E. Partridge.

## INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

Has Mental Hygiene a Practical Use in Industry? *Boyd Fisher.* Ment. Hyg., July, 1921, 5, No. 3, 479–496. — This rather long and discursive paper gives a good review of the subject from a layman's viewpoint, with certain humorous criticisms of the medical point of view and several interesting examples of good work done by physicians and others in applying mental hygiene to industry. Mr. Fisher speaks as an employment manager reviewing the question of the practical application of the principles of mental hygiene in industry and offers the following suggestions:

"First, that we consider for the present only the modern medical approach to the subject; second, that we strive to clear up misconception on the subject of mental hygiene; third, that we recognize wherein we are already employing mental hygiene in industry; and finally, that we make a cautious approach toward a more scientific and technical direction of the work we are already doing. The caution is needed not only because we lack experience to guide us, and lack even an adequate body of medical specialists, but also, especially, because the education of the public takes time, and prejudices die hard.

". . . Obviously, the first step is further enlightenment of the employment managers and physicians already doing a general sort of mental-hygiene work in industry. To this end I suggest conferences of such workers at which papers on the subject are read, if possible by psychiatrists. When these workers are informed, an effort should be made to clarify the minds of general executives on the subject, so that any later steps can be taken with proper assent. Perhaps it will then be possible to make a mental-hygiene survey of an industry. Such a survey would be a study of both the conditions affecting the mental attitude of the workers and an examination of social histories as shown on the records. Only rarely would individual personal examinations be necessary. These would be conducted so as not to indicate doubt of the employee's sanity, and perhaps would be incidental to an interview brought about ostensibly for some other purpose.

"Such a survey would then be used as a basis for further study and training or action by the regularly employed service workers. The professional psychiatrist would need to come in only as a consultant and trainer for the other personnel workers. . . .

"With all due cautions, however, and with all acknowledgements to the present state of the public understanding of the subject, mental hygiene has, in my opinion, a real and important place in industry and offers great promise of public service." — Stanley Cobb.

## INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Promoting the Health of the Employee: How the Bethlehem Shipbuilding Corporation Provides Good Food, Well Served, for its Shipbuilders. Calif. State Board of Health, Month. Bull., July, 1921, 17, No. 1, 10–18. — The Bethlehem Shipbuilding Corporation, in order to do away with the insanitary eating houses which formerly crowded around the shipyards, has provided cafeterias for its employees, which are run by a committee of workmen, and at which the food is served at cost. "The management is greatly pleased with the results. Not only are the workmen able to do better work when they secure better food but there has developed a better spirit among the shipworkers. . . . It is not purely an altruistic movement for it has been found that the inauguration of this service brings returns in dollars and cents." — M. Dent.

## INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

New York State Labor Law with Amendments, Additions and Annotations to August 1, 1921. N. Y. State Dept. Labor, 1921, pp. 141. — This pamphlet contains the labor law of the state of New York, recodified and amended by the legislature of 1921, and "certain sections of the penal law pertinent thereto." — M. C. Shorley.

Labor Agreement Laws and Industrial Supervision. *Bender.* Zentralbl. f. Gewerbehyg., July, 1921, 9, No. 7, 149–151. — This is a discussion of the proposed legislation for industrial self-government, in which scheme the supervision of health, child labor, women's work, and such matters would be done by officials responsible to employer and laborer, while larger public interests might not be well conserved. — E. L. Sevringhaus.

Provisional Regulations Regarding Policing, Safety, and Health in the Nitrate Plants. Abstracted as follows from Caliche, 1919, Vol. 1, 241, in Chem. Abstr., July 10, 1921, 15, No. 13, 2155. — "Transcription of presidential decree revising police, safety and health regulations operative in the nitrate works."

The Conflict of Jurisdiction in Compensation for Maritime Workers. *J. P. Chamberlain.* Am. Labor Legis. Rev., June, 1921, 11, No. 2, 133–142. — The position of the sailor gives rise to some difficult problems of compensation. When compensation first took the place of damages, it was assumed by the state courts that the state rules would apply, but the states could not make compensation the sole remedy for maritime accidents, since they could not deprive maritime workers of their right to bring action in the federal courts.

Decisions of courts up to the present time have not cleared up the difficulties, since, as the matter now stands, the longshoreman in loading a vessel is subject to maritime law while he is on the ship, and to local law while he is on shore. The New York courts have held that a longshoreman could not get compensation even if the accident happened on the dock, if he was actually engaged in loading or unloading a ship, but he must go to the state courts and sue there under the state law of torts. The result was that the same man, doing the same work, for the same employer, in the same place, was subject to three different systems of law. Many industries situated near shore employ men in such a way as to bring them under all three jurisdictions and are obliged therefore to carry three kinds of insurance.

A federal compensation act for seamen is the only way out of the difficulty, but reason also argues strongly for the adoption of legislation by Congress permitting the states to extend their compensation to land workers if employed occasionally on vessels. — G. E. Partridge.

Legislative Program of Accident Compensation for "Maritime" Workers. *J. B. Andrews.* Am. Labor Legis. Rev., June, 1921, 11, No. 2, 152–153. — A committee of the American Association for Labor Legislation reports in favor of extending the benefits of compensation to longshoremen and ship-repairers. Two bills have been drafted. One

tries by an amendment to the Federal Judicial Code to reserve to the local workmen rights under existing state compensation laws, and the second bill is a comprehensive Federal Workmen's Accident Compensation measure for seamen for whom there is needed such uniformity of treatment as can be secured only through a national law. The principal provisions of the bill are in most respects identical with those of the Federal Compensation Act for Civilian Employees, which was passed by Congress in 1916. — G. E. Partridge.

Proposed Death Benefit Schedule of California. U. S. Bur. Labor Statis., Month. Labor Rev., May, 1921, 12, No. 5, 1056–1057. — After making a careful study of 674 families, involving 1,686 dependents, receiving compensation, the California Industrial Accident Commission has submitted to the legislature a new death benefit schedule which it considers rational. The present workmen's compensation law provides that the dependents of a workman killed in industry shall receive three times his average annual wages, the total not to exceed \$5,000 nor to be less than \$1,000. This death benefit was found to be just sufficient in 260 of the 674 cases studied, and seriously insufficient in 298 cases; in 49 cases it was impossible to tell "whether the compensation would last long enough to meet the requirements, and in 67 cases only was the compensation more than adequate."

The study revealed that such insufficient compensation results in a marked deterioration of the health of dependents, a lowered standard of living, the splitting up of families when the children must be placed in orphanages or with relatives, an increase of children leaving school to go to work, and of homes where the mother works all day and the children run wild upon the streets.

"Under the new schedule a widow, without children and without any incurable disease, under 60 years of age is to receive 40 per cent. of the wages of her deceased husband for two years and also may be given such aid as to education and industrial training as will enable her to become self-supporting. Because of the difficulty of any woman of 60 or over to find remunerative employment and of the improbability of widows, whose average age is 37, while supporting themselves, being able to save enough to provide for the time after they are 60, it is proposed that all widows who upon attaining the age of 60 have not remarried shall be entitled to a life pension of 40 per cent. of the wages of their deceased husbands. A widow with an incurable disease which incapacitates her from earning is to receive 40 per cent. of the wages of her husband as long as such incapacity continues.

"For widows with children the new schedule provides that the widow is to receive for herself 40 per cent. of the earnings of her husband, to be paid until two years after her youngest child has ceased to be dependent, provision being made for a life pension after reaching the age of 60. For one child there is to be paid her 15 per cent. of the wages of her husband and for each additional child 10 per cent., with a maximum of 100 per cent.

"If the widow remarries the payment of one year's compensation in a lump sum is to close her case, but the children's compensation will continue until they severally reach the age of 16. . . .

"To meet these reasonable needs the new schedule provides that the death benefit shall equal four times the average annual earnings of the deceased employee, to be paid by the employer or insurance carrier for each employee killed, whether or not there are dependents. Security of the payments to widows and children is provided through the creation of a special trust fund, into which the employer or insurance carrier shall pay the death benefit, in reasonable installments. This fund shall be administered by the state compensation insurance fund, which shall pay therefrom the benefits awarded by the commission. The fund shall be invested and reinvested as other funds of the state compensation insurance fund are, the only cost to be the reasonable expense of administration, any lapses or interest to go into the death benefit fund." — M. Dent.

Old Age Pensions Legislation in France. Internat. Labour Rev., April, 1921, 2, No. 1, 67–88. — Workers' and peasants' pensions in France date from 1910, but the original legislation relating to them has since been amended. The act has reference to compulsory insurance and voluntary insurance. Compulsory insurance applies to wage earners of both sexes, but does not as a rule include state employees. Every insured person must pay an annual amount, deducted from his earnings by the employer. The pensions are commonly annuities. In 1912 the pension age was fixed at 60-

years, and at that age the worker becomes beneficiary of the fund accumulated by his own savings, the contributions of employers and an additional amount of 100 francs per year provided by the government under certain conditions, and increased if the insured person has brought up to the age of 16 at least three children. Persons totally or permanently incapacitated may have anticipated payment of their pensions. The survivors of an insured person — under certain specified conditions — receive stipends. The administration of insurance is intrusted to the National Old Age Pensions Fund, but certain private organizations, such as mutual aid societies, are accepted.

Voluntary insurance "is especially intended to bring within the scope of the act groups which are economically independent, but which live under conditions similar to those under which the workers live." These include tenant farmers, *métayers*, independent farmers, artisans, small employers who for the most part work alone, and other classes exempt from compulsory insurance. All these have the same rights as those compulsorily insured.

In the administration of the act a special committee in each *commune*, composed of the mayor, one employer, and one wage earner, takes an important part, but all claims come before the magistrates, and are dealt with, in case of dispute, in common law. Various difficulties have been met in the administration of the act, and it is especially noticeable that voluntary insurance has been taken advantage of in disproportionate amount by persons of advanced age.

The working of the act has not been in the highest degree satisfactory, evidence of which is a decrease in the number of registrations, and the fact that in 1913 only 45,500,000 of the 177,000,000 francs expected were paid in: that is, of a total of about 7,000,000 persons liable to compulsory insurance, less than 3,000,000 complied with the regulations. The war upset the working of the plan, but there are other factors affecting its satisfactory operation. The report for 1917 to 1918, for example, shows that whereas the act is relatively satisfactory in the eastern industrial districts, where social education is more advanced, and in the central agricultural districts, where contributions for voluntary insurance have been made in large numbers, the act has been less fully complied with in the western agricultural districts. Domestic servants (especially women servants) and agricultural workers (especially farm servants) have not kept well the provisions of the law. Opposition on the part of employers has added to the difficulties — the small employer and the farmer class especially disliking the plan, which involves additional expense. The opposition is often covert, and the employee fears dismissal if he attempts to fulfil his part.

The conclusion must be made that the Workers' Old Age Pensions Act has been inadequate. An amendment is needed to make effective the compulsory nature of the act. It is suggested in an official report that employers should be penalized for failing to deduct the worker's contribution, even when the latter does not present his card. This, however, would remove only a part of the obstacles, since employees themselves have lacked interest. Statistics of the mutual aid societies confirm other evidence of this. As regards remedy, "it would seem essential considerably to raise the amounts of the benefits and to require much larger contributions on the part of the beneficiaries, the employers and the state." A bill now pending, which attempts a transformation of the Workers' and Peasants' Old Age Pensions Act into a new system calculated to be really popular with the working classes is wisely projected.

The article contains eight tables, and, besides the matter summarized, other data somewhat local in interest. — G. E. Partridge.

Social Insurance Systems in Portugal. Abstracted as follows from Bulletin du ministère du Travail, 1920, Nos. 11 and 12, in Il Lavoro, April 30, 1921, 11, No. 12, 368–370. — Compulsory insurance against accidents, sickness, invalidity, and old age was required in Portugal by a measure passed in May, 1919. The administration of the law is intrusted to a special institute which supervises the work of different insurance societies and of workmen's organizations. This institute is supported by the state and by these societies. All citizens between the ages of 15 and 75 years must take out insurance against sickness in some mutual society. Two classes of insured are recognized: the first comprising persons with an income above 900 milreis*, who pay a monthly sum of from 50 to 300 reis without state subsidy; the second consisting of persons with an income less than this who receive state subsidy and

* One milreis = 1,000 reis = $\$1.07\frac{1}{2}$.

pay from 50 down to 30 reis monthly. At the end of three months the insured has a right to medical care at home or in a hospital, and also to reimbursement for the expenses in case of sickness of his wife and of his children under 15 years of age or of other persons whom he supports. After six months of insurance he is entitled to receive a subsidy which varies according to his wages and the duration of his sickness.

Insurance against accidents was provided by a law of 1913. The present measure renders obligatory insurance against accidents, and places the insuring bodies under the institute. Any lesion, external or internal, including nervous and psychic lesions caused by an external agent during the hours of employment, is reckoned as an accident. In case of death the wife of the deceased, even if legally separated from him, receives a pension equal to 20 per cent. of the annual wages of the deceased. The orphans up to the age of 14 years receive an additional 20 per cent., the whole not to exceed 60 per cent. Girls have a right to such pension up to 16 years of age. Funeral expenses, not to exceed fifteen times the daily wage of the deceased, must be paid by the employer.

Insurance against invalidity and old age provides for the underwriting by the commune or parish, and the insured are divided into those who work for wages at home or in factories or on the land and whose income is under 900 milreis, and the non-wage earners of the agricultural, industrial, commercial, and professional classes. Employees must contribute $1\frac{1}{2}$ per cent. of the daily wage, the employer 6 per cent. of his payroll. If the insured dies after having made five annual payments his children or his childless widow receives a pension of 50 milreis payable in six months. The pension for old age begins at 70 years and is equal to the entire salary.

This law also reorganizes the bureaus of labor in Lisbon and Porto, placing them under the ministry of labor. They collect information from their localities and undertake to decide controversial matters. Each is represented by a commission of five members, two of whom are elected by the trade unions and three, including the president, are appointed by the government. — Alice Hamilton.

## REHABILITATION OF DISABLED EMPLOYEES

Vocational Training vs. Occupational Therapy. *Philip King Brown.* Nation's Health, Sept. 15, 1921, 3, No. 9, 536, 22 Adv. — The principles of ergotherapy as worked out under strict medical supervision at the Arequipa Sanatorium for tuberculous wage-earning women are herewith presented in brief. It seems that a growing emphasis is being put upon such occupations as may lead to some practical advantage to the patient. Ergotherapy may be criticized because too often work is assigned which has neither commercial, educational, nor artistic value. On the other hand, the attempt to attain any one of these values often causes the patient and the director to lose sight of the possible dangers of overeffort, if the procedure is at all forced. — L. A. Shaw.

Chicago Service League Restores Handicapped to Industry. Mod. Hosp., June, 1921, 16, No. 6, 527–529. — "The Service League for the Handicapped, in Chicago, is 'organized effectively to reconstruct, re-educate, and retrain the handicapped from disease or accident, and to replace them in self-supporting positions.' It is the object of the league to retrain the handicapped along the lines in which they were useful before they became handicapped, thus restoring to the community as much of the service and efficiency that belonged to it before, as it is possible to do. The mental effect of this method is also good, for it is more normal to go on doing as nearly as possible the same thing that one is used to doing than to have the new conditions emphasized by taking up a strange vocation."

The applicants come to the league from many different sources, such as the Red Cross, charitable organizations, and individuals. When a man comes into the league, he is given a registration blank to fill out, giving the usual information concerning education, the cause of the handicap, treatment undergone, former employment, and references. He is then sent to one of the members of the medical board who are connected with various hospitals of the city, for a free medical examination. This diagnosis determines the man's classification. If he needs hospital treatment, or observation in a hospital for a time, he pays $3 a day if he can afford it, if not, either the league pays it, or

a free bed is secured. If the man needs re-education, he is put in the training school which the league maintains. If he can be placed immediately, and a suitable position is available, that is done.

The men are classified according to the character of the position wanted: factory, store, business, etc. The league has a list of 200 firms in Chicago and from this list an effort is made to pick out those most likely to have the desired position, and to place the applicant there. — M. C. Shorley.

Problems of Maintenance in Vocational Rehabilitation. *John A. Kratz.* Voc. Summary, May, 1921, 4, No. 1, 16–17. — In vocational rehabilitation, the first matter to be considered is maintenance during training. Persons eligible to compensation under compensation laws usually receive enough to provide for this, but in many other cases the question of maintenance is one which has to be solved. A large proportion of potential cases also must be sought out and persuaded to accept the services of the rehabilitation agency, especially if there has been large compensation.

In many instances men are found to have savings sufficient for undergoing training. The immediate problem of the rehabilitation agent in such cases is to convince the man of the wisdom of investing his savings in training. When there are no savings or private income, an industrial bank, a Morris plan bank, the employer, or relatives, or some organization or disinterested persons may be appealed to. Sometimes the only solution is to place the handicapped person immediately in some type of employment that makes possible self-support during the training period. — G. E. Partridge.

On the Severely but not Totally Disabled in Industry, with Special Reference to the One-Armed. *Leo Eloesser.* Boston Med. and Surg. Jour., May 12, 1921, 184, No. 19, 489–495. — The author concludes as follows: "1. Compensation for the severely but not totally disabled should be made on a combined basis of: (*a*) physical impairment due to injury; (*b*) previous occupation.

"2. All severely injured should be given opportunity for vocational training.

"3. The new career should utilize and be based upon the injured man's previous knowledge and experience.

"4. Whether to continue training should depend upon the man's intelligence and fitness for a new career.

"5. Training should be stopped if progress does not warrant its continuance.

"6. Laborers trained in agriculture should be offered inducements to accept compensation in land instead of money.

"7. Compensation should be contingent upon the injured engaging in profitable occupation.

"8. Suitable employment should be furnished by the state, if necessary." — Barnett Cohen.

Occupations in the Automobile Industry as Employment Objectives for the Disabled. Voc. Summary, May, 1921, 4, No. 1, 4–5. — Physical ability to do the work for which the man is trained is the main factor in the problem of rehabilitating ex-service men for permanent occupation. Hirschmann has recently compiled a report on *Disabilities and their Relationship to Occupation in the Automobile Industry*, based upon an inspection of the United States Army Motor Transport School at Camp Holabird, Md., in which it is shown that in this work disabilities may be a serious handicap. A large part of the work is heavy work, and some branches of it are unsuitable for men having affections of the lungs, on account of the prevalence of dust. Work in the repair shop, tearing down and repairing, is contraindicated for men having injuries to the back; it also requires the use of two good arms. The fumes from engines and exhausts are also bad for some men. Work in the woodworking shop is also heavy and not suitable for men with orthopedic conditions. Acetylene welding requires normal vision and sound respiratory organs. Noise and smoke that prevail in the blacksmithing work are bad for men with functional nervous diseases or respiratory conditions, and blacksmithing is too heavy for men with heart affections. Vulcanizing, upholstering and painting are all processes that are bad for certain types of men.

"It would seem, then, that almost any type of general auto mechanics except lighting, starting, ignition, and diagnostician work is contraindicative for men with serious disabilities." And for these types of work good vision, free use of the hands, and a good general knowledge of the automobile are necessary. — G. E. Partridge.

## INDUSTRIAL MORTALITY AND MORBIDITY STATISTICS

Sickness Frequency among Industrial Employees. U. S. Pub. Health Ser., Pub. Health Rep., July 1, 1921, 36, No. 26, 1497–1502. — The figures upon which this report is based were supplied by sick-benefit associations of employees, and are for the entire year 1920. The existence of waiting periods and limitations as regards age placed by the associations prevents the results from being entirely comparable with other reports of similar materials.

The data are presented in a table and a graph. The table shows the frequency of types of disease, and of the main diseases within each group, and also the frequency of all diseases given in each case for each month. Sickness was least during September, and if we take this month as the beginning of the cycle, the rate increases through February and then declines to the end of the period. The graph shows the frequency for all diseases, for all diseases exclusive of influenza, for diseases of the digestive system, for diseases of the nervous system, and for general diseases exclusive of influenza. "One of the striking facts to be noted in this graph is the tendency for disability from all causes, after taking out influenza, and for illness due to diseases of the respiratory system, to be relatively high during the influenza epidemic." — G. E. Partridge.

Sickness among New York State Factory Workers in 1919. New York State Dept. Labor, Special Bull. No. 108, Aug., 1921, pp. 29. — "1. This survey covered more definitely the people who would be insured under a health insurance law than any other survey of similar scope.

"2. The method of investigation gives information regarding the prevalence and trend of the various diseases in successive months of the year.

"3. The approximate loss of time among factory employees covered by this survey that would be compensable under a health insurance law, such as has been proposed in this state, was 1.1 days per employee for the last half of 1919. As health conditions were probably above normal during that period, the minimum estimate for a full year to be derived from the above figure is $2\frac{1}{3}$ days per employee.

"4. This estimate must not be interpreted as covering *all* sickness among factory workers. Similarly, it should not be assumed that *all* sickness among factory workers would be compensable under proposed health insurance measures.

"5. The annual wage loss among factory workers of New York State for time that would be compensable under a compulsory health insurance law, such as has been proposed, is not less than $13,000,000 at the wage rates prevailing during the last half of 1919. This estimate is based on the assumption that 1,500,000 factory workers are employed in this state, as indicated by the factory inspection records for the year 1919–1920.

"6. The majority of the cases of sickness reported in this survey were not covered by any form of health insurance."

The appendix contains tables showing sickness among factory workers, by months; sickness among factory workers, by industry; distribution of cases of sickness, by disease; distribution of cases of sickness for each sex, by disease; distribution of cases of sickness, by months and disease; percentage distribution of cases of sickness, by months and disease; distribution of cases of sickness, by length of disability and disease; distribution of cases of sickness and time and wage loss, by length of disability; and wage rates reported on sickness records. — M. C. Shorley.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

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## CONTENTS



## GENERAL

WAR AND INDUSTRIAL DISEASES. *L. Teleky.* Internat. Labour Rev., July–Aug., 1921, 3, Nos. 1–2, 51–77. — This is a valuable paper, in which the writer has reviewed in considerable detail the experiences of the industries during the war, especially with respect to poisons. He treats metal poisonings (plumbism, mercury and arsenic poisoning), poisoning by nitrogen fumes, anthrax poisoning, poisoning from injurious substitutes, from oils and fats and their substitutes, from nitro-compounds, T.N.T., and D.N.B., and "poisoning from various causes." The information is taken from the reports of factory inspectors in Germany, Austria, the United Kingdom, the Netherlands, and Switzerland, and from other sources.

British reports show that the manufacture of lead containers for acids, etc., gave rise to cases of plumbism, and in 1915 there was a considerable increase in the number of cases of poisoning occurring in the manufacture of accumulators. The use of iron oxide and micaceous paints has been so widespread in Germany that "in future it is to be hoped that leadless paints will be used altogether.

Mercury poisoning was caused by the use of mercury for alloys which had formerly been made with tin. Koelsch reports at least 116 cases of mercury poisoning in a chemical works preparing mercury and oxide of mercury. There were a large number of cases of injuries traceable to fulminate of mercury, among them inflammation of the gums, blackening and brittleness of the teeth (produced presumably by fulminic acid, HO-N-C), irritation of the conjunctiva and upper bronchial passages, and especially exanthema and erythema. Many workers in German and Austrian factories employed on fulminate of mercury or fulminate salts suffered from these disorders.

Two forms of the effects of arsenic poisoning have been noticed: the effect of arsenates, especially on the skin; and poisoning by arseniuretted hydrogen. The development of the dye industry in England led to frequent poisoning by arseniuretted hydrogen, many cases ending fatally; and many mild cases occurred in crews of submarines, as a result of the production of arseniuretted hydrogen by the accumulators.

Poisoning by nitrogen fumes happened in munitions manufacture and in various industries. Cases occurred in the making of nitric acid, and there were some from the use of sulphuric acid which was a by-product of the manufacture of explosives and contained nitric acid and nitrogen substances. Nitrogen poisoning also occurred frequently in England in the manufacture of nitric acid, and there were some cases in the making of picric acid and trinitrotoluol and also gun-cotton.

Many cases of skin disease were caused in certain industries by lubricating oils, polishes, varnishes and lacs. Substitutes were used not only for animal and vegetable fats but for mineral oil products and resin. Distillation of coal tar and lignite tar was resorted to, and these substances caused many cases of skin disease. Fischer reports "tar oil with resinous mixtures" as a cause of "oil itch." The substitute lubricants were widely used in a variety of industries, and the skin diseases were widespread. Many injuries were caused by the medical use of "war vaseline," etc. Tar products, also, produced skin diseases.

Poisoning was caused by the use of benzol as a solvent, as in varnishes, on account of shortage of oil of turpentine and benzine; and other paint and varnish solvents, such as solvent naphtha and acetone, caused cases of poisoning. Especially the varnish used for aeroplanes and aeroplane wings was often dangerous. Acetylcellulose was used, the most important solvent of which is tetrachlorethane which produces an effect similar to that of chloroform, but is four times as poisonous, and its hematolytic effect is 7.6 times as great. Its effects take partly the form of nervous symptoms (trembling, paresthesia, disappearance of the patellar reflex, etc.) and partly occur as nausea, acute jaundice and atrophy of the liver. Realization of the dangers led to the use of substitutes, but these are by no means harmless. Formic acid, ketone, methylated alcohol, and acetone and its derivatives were all causes of more or less severe illness.

Much use was made in the war industries of nitro-compounds, and particularly of aromatic nitro-compounds, especially dinitrobenzol and dinitrotoluene, poisons which could be introduced into the system not only by inhalation but by absorption through the skin. Aromatic nitro-compounds act principally as blood poisons, causing the formation of methemoglobin and the destruction of red corpuscles, women being particularly susceptible — although there are some doubtful points in regard to this. The use of alcohol greatly aggravates the effects. But everywhere improved working arrangements, shortening of hours, and medical inspection, proved beneficial in reducing the amount of poisoning from the nitro-compounds.

In Germany dinitrobenzol was chiefly used as an explosive, sometimes alone and sometimes in combination; but in England and the United States trinitrotoluene played a preponderant part. Whether trinitrotoluene is or is not a poison is still an unsolved problem. The use of it in the war certainly led to severe cases of poisoning, but both Koelsch and Fischer came to the conclusion that T.N.T. is in itself non-poisonous, and that impurities which, under certain circumstances, adhere to T.N.T. when used in manufacture have been the cause of the poisonous effects. In England, during the war, there were many cases of jaundice, some of progressive anemia, and a great number of cases of debility, disturbance of digestion, etc.; and "the position in the American factories was terrible" — 17,000 cases in the first seven and a half months, with 475 deaths.

The T.N.T. manufactured in England and America must clearly have been poisonous, and susceptibility of individuals, etc., is not a satisfactory explanation. The probable cause of the difference of findings in different countries is the diversity of the substances themselves as regards impurities. Some of the impurities are known: *e. g.*, tetranitromethane, an undoubted cause of certain symptoms, dinitrotoluene and mononitrotoluene (dinitrotoluene, however, appearing to be no more poisonous than T.N.T. itself).

Other poisonous bodies of the aromatic series are trinitronaphthaline, which in the form of powder produced an acute irritation of the skin; trinitroanisol, also strongly irritating to the skin; nitroglycol, causing giddiness, etc.; dini-

trochlorobenzol, producing severe dermatitis; picric acid, producing such symptoms as headache, giddiness and stomach troubles; tetranitromethane, a strong irritant of the respiratory tract; and phosgene gas. Precautionary measures were effective in reducing the amount of injury — instruction, provision of oxygen apparatus and medicines, medical selection and supervision of workers (very necessary and useful); and the war has shown the very great value of collaboration of the medical profession in factory inspection. Medical knowledge alone can detect the appearance of new diseases and ensure the prevention of industrial sickness. As a result of the experiences of the war, also, the introduction or extension of compulsory notification of industrial diseases is being discussed in Germany — a measure which had many years before been introduced in England where, in the opinion of the writer, there was much better preparation for the prevention of war industrial diseases. — G. E. Partridge.

The Problem of Industrial Hygiene and the Co-operation of Physicians in Industrial Supervision. *H. Rasch.* Zentralbl. f. Gewerbehyg., Aug., 1921, 9, No. 8, 168–171. — This is a general discussion calling attention to the many kinds of situations in which medical men must be called upon for help in industrial hygiene work. — E. L. Sevringhaus.

Discussion of the Importance of Industrial Medicine to the Community. *Edgar L. Collis.* Brit. Med. Jour., Aug. 27, 1921, No. 3165, 315–317. — This article covers material similar to that contained in the International Journal of Public Health, March–April, 1921, and abstracted in This Journal, Oct., 1921, 3, No. 6, 123. — M. Dent.

# SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

## CENTRAL NERVOUS SYSTEM

Neuroses in Business Life. *L. Casamajor.* Abstracted as follows from Neurol. Bull., July, 1921, 3, No. 7, 237, in Jour. Am. Med. Assn., Oct. 15, 1921, 77, No. 16, 1285. — "Casamajor presents illustrative cases which fall into three groups: (1) the inadequate; (2) the dissatisfied; (3) the generally maladjusted. The dissatisfied group is the largest, for it includes the great majority of the neuroses of business life. The neurosis arises in the individual who likes the remuneration he gets from his work but dislikes the work itself and the type of life it forces him to lead. The symptoms are not usually severe and most of these patients struggle on without applying for medical aid. However, should the patient suffer an accident for which the employer could be held responsible, a typical traumatic, litigation neurosis might easily appear. The difficulties of the generally maladjusted in business life are only a part of their general maladjustment. The maladjustment to the home life is of much greater importance, and the work is a means of escape from the home. The similarity between the neuroses of business life and the war neuroses is quite obvious. Dissatisfaction is ever rife throughout industrial life and the neurosis is a way out of a difficult problem." — C. K. Drinker.

## CIRCULATORY SYSTEM

The Effect of Increased Protection from Radiation upon the Blood Condition of Radium Workers. *J. C. Mottram.* Abstracted as follows from Arch. Radiol. and Electroth., 1921, Vol. 25, 368, in Med. Sc., Nov., 1921, 5, No. 2, 186. — "In 1920 the author published his findings upon the corpuscular content of the blood in workers in the Radium Institute, London. He described a profound leucopenia affecting both polynuclears and lymphocytes together with a mild anaemia accompanied by a high-colour index. Since these investigations were made increased protection from irradiation was afforded the workers, and the present paper indicates the results after such increased protection had been in operation for six months. The observations bear upon five males and five females. In respect of red cells the blood count in all the females and two of the males had risen, and now presents approximately a median value which is regarded as 5.5 million for males and 4.9 million for females. In one male the value has risen slightly but is still low, and in

the remaining two males a fall has occurred which may be partially explicable on other grounds. In respect of polynuclear cells the five lowest original counts show considerable approaches towards the normal, and the two lowest lymphocyte counts also show a rise, otherwise little change is noted in the leucocytic counts. The actual protective devices employed consist in protection from emanation, improved ventilation of the rooms, manipulation of emanation applicators before the active deposit has been fully formed, use of long-handled wooden forceps, diminished handling of the applicators during transit and, in actual clinical use, leather lined lead rubber gloves. In the screening of applicators and against gamma radiation generally temporary workers are used as far as possible. The lead screens on the tables and those behind which the manipulations are carried out are 5 cm. thick. Due instruction is also given the workers as to how advantage may be taken of these protective devices." — M. Dent.

## RESPIRATORY SYSTEM

A Case of Secondary Infection with a Parasitic Mold in a Coal Heaver. *Pezzali.* Abstracted from Gior. di Clinica Med., April 10, 1921, No. 6, in Il Lavoro, Aug. 31, 1921, 12, No. 4, 110–111. — A workman of 60 years employed in unloading coal came to the hospital with inflammation of the lungs and after eighteen days died of exhaustion. There were symptoms of infiltration of both apices, moist râles over the whole chest, and a muco-purulent anthracotic sputum which contained no tubercle bacilli, but in addition to staphylococci and diplococci, numerous spore bearing clubs, conidia of Ascomycetes. Cultures produced an abundant growth of filaments forming a mycelium of the mold Penicillium. This case is very exceptional since, according to the author, Castellani is the only one who has described cases of bronchitis and broncho alveolitis accompanied by the growth of Penicillium. In other cases the fungus has proved to be Aspergillus. — Alice Hamilton.

# POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

The Treatment of Carbon Monoxid Poisoning. *Howard W. Haggard* and *Yandell Henderson.* Jour. Am. Med. Assn., Oct. 1, 1921, 77, No. 14, 1065–1067. — Carbon monoxide asphyxia is of extremely common occurrence and is a condition upon which both the public and the medical profession entertain most erroneous ideas.

In the course of a large series of investigations the authors and their associates have marked out the following standard for exposure: "Multiply the time of exposure in hours by the concentration of the gas in parts per 10,000 of air. If the product equals 3 or less there is no appreciable physiologic effect. If it equals 6, there is sometimes slight malaise. If it equals 9, a headache with some nausea is produced in most people. If it equals 15, the conditions are dangerous for anything beyond brief exposure. If it is more than 15 they are extremely dangerous even for brief exposure."

In the proposed vehicular tunnel under the Hudson, carbon monoxide is not to be permitted to rise above 4 to 5 parts per 10,000, and the time for passage will be from fifteen to thirty minutes. Fieldner and his associates have shown that an automobile engine may produce from 1 to 2 cubic feet of carbon monoxide per minute. Thus, a car warming up in a small closed garage can make an atmosphere dangerous to life within five minutes. Production of carbon monoxide increases on a rich mixture and decreases on a thin one.

The whole toxicity of carbon monoxide has been shown to depend upon its union with hemoglobin. Illuminating gas and exhaust gas from automobiles contain other substances, for example benzene, which add to their poisonous properties. Search should be made for these and pressure applied to prevent their appearance in illuminating gas.

The therapy of carbon monoxide poisoning depends on the hemoglobin combination mentioned above and upon the fact that this combination is readily reversible. When poisoning begins, the blood gradually takes up carbon monoxide and the resulting oxygen deficiency induces an augmentation of the volume of air breathed per minute. This results in bringing more carbon monoxide into the alveoli per minute and in washing out carbon dioxide

which is the normal stimulus for breathing. If after such a process has progressed the patient is removed to the open air, carbon dioxide removal may have progressed so far as to cause respiration to stop for lack of this stimulus or else respiration is so feeble that elimination of carbon monoxide occurs with extreme slowness. If breathing could be made vigorous the patient would not only spare his tissues further asphyxiation but would actively rid himself of the poison already present. The authors propose that inhalations of oxygen containing from 8 to 10 per cent. of carbon dioxide be used. The carbon dioxide in this mixture will induce full respiration and the mass action of the oxygen will displace carbon monoxide from the blood. — C. K. Drinker.

Acute Carbon Monoxide Poisoning. *M. Nicloux.* Abstracted as follows from Presse méd., Sept. 3, 1921, 29, No. 71, 701, in Jour. Am. Med. Assn., Oct. 15, 1921, 77, No. 16, 1289. — "Nicloux emphasizes that the blood corpuscles even saturated with carbon monoxid are not devitalized at all, but are ready to resume functioning with a little aid, that is, when supplied with oxygen. In a case described, seventy-five minutes after the poisoning, and after 650 liters of oxygen had been administered by the pulmotor, the blood still contained 9.08 per cent. carbon monoxid, showing that 41.3 per cent. of the hemoglobin was saturated with it. The oxygen was pushed, and in about an hour this percentage was only 25.4, and four hours later, 8.3. The survival of this patient after apparent death for twenty-five minutes shows that even 9.08 per cent. of carbon monoxid in the blood is not fatal. In the cases on record in which death occurred with poisoning of 0.1, 0.3 or even 0.4, Nicloux is convinced that some other factor than this poison was responsible for the fatality. Hartridge experimented on himself, and found that distressing symptoms did not follow until he had surpassed the figures reached in this case. The slightest movement is liable to bring on vertigo and loss of consciousness. This occurred twice in this case, the man saying he felt well and wanted to go home, and becoming unconscious when he started to get up. The pulmotor had been used beginning five minutes after apparent death which kept up for twenty minutes longer. About 650 liters of oxygen had been used and more was given in the hospital, for twenty minutes each hour, to a total of 1,500 liters. The headache and vertigo disappeared after the first inhalation." — C. K. Drinker.

Personal Experience of Poisoning by Arsine. *H. Kunz-Krause.* Vrtljschr. f. gerichtl. Med., April, 1921, 61, No. 2, 161. — At 11 o'clock one morning, upon opening an old cupboard which was used for storing waste chemicals, the author was greeted by a strong garlic-like odor, as of arsine. He thought nothing more of it till 8 P.M., when he began to feel mildly indisposed. His distress increased so much in an hour that he was unable to eat his supper. He retired soon afterwards and went to sleep, but at midnight he awoke with severe dyspnea, and a thready and weak pulse. The desire for air was so great that he rushed to the window and felt an almost irresistible inclination to throw himself out. He was helped to a nearby physician's office, where he recovered sufficiently by 4 A.M. to take some mild alkaline mineral water. His alarming symptoms and accompanying nausea subsided so that by 5 o'clock he could return to bed. The resulting depression wore off in the course of the next day.

The professor explained the presence of arsine by the fact that, as he afterwards discovered, a container of arsenic had leaked into the cupboard, and that molds (such as Penicillium brevicaule) had formed this poison gas or possibly diethylarsine. — H. G. Noyes.

The Local Effect of Dimethylsulphate. *Josef Bodenstein.* Wien. klin. Wchnschr., May 12, 1921, 34, No. 19, 226–227. — Dimethylsulphate has been used in chemical industry since 1900 as an alkylating agent in place of methyl iodide. The sulphate is very toxic. Inhalation of the "gray vapor" from an open kettle resulted in acute irritation of the respiratory mucosa and death from lung edema and lobular pneumonia. In the less fatal cases, there is a persistent laryngitis, tracheitis, bronchitis and conjunctivitis lasting for months. The local effect is probably due to the free acid liberated, while damage to the central nervous system and the parenchymatous organs is due to the whole molecule.

A case is described in which a few drops, at most, of dimethylsulphate were swallowed. The burn produced was similar to that made by sulphuric acid. Recovery was very slow. — Barnett Cohen.

A Simpler Method of Blood Examination for Suspected Cases of Lead Poisoning. *L. Schwarz.* Med. Klin., May 29, 1921, 17, No. 22, 659–660. — Much time and costly reagents may be saved when testing blood for suspected lead poisoning in large groups of workers in the lead industry, if thick drops are used instead of the usual thin smears. The stain is Manson's borax methylene blue, made from 5 gm. borax in 100 c.c. boiling, distilled water plus 2 gm. methylene blue. This will keep for six weeks. For staining, thin it in a reagent glass until transparent. Stain the unfixed thick drop ten minutes. Basophilia may then be ruled out by examination of only ten to twenty fields, whereas 200 or more must be gone over in a thin smear. — H. G. Noyes.

On Blood Examination by the Thick Drop Method in Suspected Lead Poisoning. *L. Schwarz.* Zentralbl. f. Gewerbehyg., Sept., 1921, 9, No. 9, 192–194. — By the author's thick drop method the detection of stippled cells is much easier and less time consuming than by the ordinary thin smear methods. He states that the examination of ten fields in a thick drop preparation discloses more stippled cells than does the examination of 200 fields in an ordinary smear preparation. He was able to collect stains and examine the blood of fifty-one cases in three and one-half hours. The technic is published in *Medizinische Klinik*, 1921, 17, No. 22, 659, see preceding abstract. — J. A. Key.

For the Complete Suppression of Industrial Saturnism. *L. Devoto.* Il Lavoro, Aug. 31, 1921, 12, No. 4, 97 100. — Devoto has found, after a study of lead poisoning in Milan between 1910 and 1920, that the latter has been diminishing to a very gratifying extent both in incidence and in severity. He warns, however, against any relaxation of the precautions which are in part responsible for this improvement, for the protection of the workman can be provided only by appropriate legislation. It is impossible for him to protect himself. Since one of the chief causes of the diminution of industrial plumbism must be attributed to the lessened production and use of white lead after 1914, Devoto feels that with the resumption of industry the evil may return, and he therefore advocates strongly the proposal that the International Congress of Labour at its October meeting in Geneva should adopt a resolution for the prohibition of white lead manufacture and the use of white lead in industry. — Alice Hamilton.

Prohibition of the Use of White Lead in Painting. Internat. Labour Office, Studies and Reports, Series F., Oct. 24, 1921, No. 5, pp. 27. — This memorandum was issued by the Union of Painters, Varnishers, Decorators, Color Workers, and Whitewashers of Germany for the purpose of submitting to the International Labour Conference for discussion material collected on the subject of lead poisoning in industry. The following topics are treated rather fully: working and living conditions in the painting and varnishing trades; characteristic symptoms of disease among painters; genesis of lead poisoning; diagnosis of lead poisoning; symptoms of lead poisoning; causes of lead poisoning in the painting industry; statistics of lead poisoning; substitutes for white lead.

"It is clear from the above report that the use of poisonous lead paints places the workers in the painting and varnishing trades in danger of the most serious injury to health and, in its remoter consequences, of degeneration and moral deterioration.

"These dangers are further greatly increased:

"(1) by the difficulty of diagnosing plumbism and by the insidious development of this disease;

"(2) by the unsatisfactory social conditions of workers in the painting trade, which are due to economic causes and the conditions of their work;

"(3) by the impossibility of carrying out effective measures of protection, which is due to the fact that painting is a small-scale industry and that the places of work, outside the actual workshop, are constantly changing and are generally equipped in a very primitive way.

"It would, therefore, be consistent to demand a general prohibition of the use of lead paints. In consideration, however, of the very small quantities of mixed lead-containing paints and of certain paints for protection against rust which are used, we confine our claims to the prohibition of white lead, which is used in very considerable quantities and is particularly dangerous to health on account of the large amount of poison which it contains. We therefore demand, in the interest of the workers whom we represent and on general grounds of public welfare, the prohibition of the use of white lead in both indoor and outdoor painting." — M. C. Shorley.

## DUST HAZARDS AND THEIR EFFECTS

Is Prophylaxis Feasible in Arsenous Dust? Safety Engin., Sept., 1921, 42, No. 3, 100–102. — Dr. Lawrence G. Dunlap, in an article published in the *Journal of the American Medical Association*, mentioned "among the preventive measures ineffective in connection with the breathing of arsenous dust, gas masks, because 'not feasible for a workman on an 8-hour shift,' and nose guards, respirators, etc., as leading to severe dermatitis. Camphor-menthol ointment and 'baghouse salve' were the only prophylactics endorsed by Dr. Dunlap, and he cautioned that their use must be constant." The editors of *Safety Engineering* asked prominent manufacturers for an expression of their opinions as to these statements of Dr. Dunlap's, and the answers which were received are printed here, together with a reply from Dr. Dunlap. — M. Dent.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Case of Pneumoconiosis. *E. Grahn.* Abstracted as follows from Tubercle, Sept., 1921, 2, No. 12, 542, in Jour. Am. Med. Assn., Oct. 22, 1921, 77, No. 17, 1372. — "Clinically Grahn's case seemed to be one of advanced tuberculosis, and it was chiefly the appearance of the expectoration and the lack of tubercle bacilli in the latter as well as the limited distribution of the râles that caused him to doubt the existence of tuberculosis. The patient's general health prevented roentgenologic examination." — C. K. Drinker.

Tuberculosis after Industrial Accidents. *A. Broca.* Abstracted as follows from Bull. de l'Acad. de méd., May 31, 1921, Vol. 85, 629, in Am. Rev. Tuberc., Oct., 1921, 5, No. 8, 153. — "Broca recalls that there is a history of visceral or glandular tuberculosis in practically every case of tuberculous lesions in bones or joints. On the other hand, tubercle bacilli are very rarely found in the blood in the chronic tuberculous. Still another argument against the traumatic origin of bone and joint tuberculosis is his discovery that none of 500 children whom he has treated for contusions, sprains or other trauma before 1913 has developed a tuberculous process since in the region of the injury. The industrial accident which every one is so prone to hold responsible for the tuberculous lesion in reality probably merely revealed its unsuspected presence. The movement which reveals the pathological condition may not be greater or more vigorous than the ordinary movements, although claimed as trauma by the subject. Two important practical conclusions are evident from his data. One is that every accident involving a bone or joint should be radiographed immediately; this would do away with the necessity for much litigation. The other conclusion is that any history of a tuberculous bone or joint affection should exempt from military service, with its right to a pension, for any affection declared or aggravated later than sixty days after being enrolled." — M. C. Shorley.

Tuberculosis in New York City Attacks Men Especially. *Godias J. Drolet.* Revised from Bull. N. Y. Tuberc. Assn., Sept.-Oct., 1921, 2, No. 4, 1–2. — Almost twice as many men as women die from tuberculosis in New York City. Since 1910 the number of deaths of women and female children, from all forms of tuberculosis, has been 31,148, whereas the deaths of men and male children in the same period have totalled 67,748. The percentage is 64 for men and 36 for women.

The federal census figures now at hand show that the population in New York is practically evenly divided between the male and female sexes, there having been found 2,802,638 males and 2,817,410 females at the time of the enumeration on January 1, 1920. The death rate per 100,000 in each sex is shown in the accompanying table.

In 1910 the death rate in New York City from all forms of tuberculosis was 266 per 100,000 among males and 155 among females. In 1920 it had come down to 149 in the male sex, and 103 in the female. The first striking difference, of course, is the constantly higher death rate among those of the male sex; and, secondly, the decline in both groups, namely,

44 per cent. reduction in the death rate among males as against 33 per cent. among females. This decline has continued so far this year, and we therefore have the encouraging knowledge that in the past eleven years alone the death rate from tuberculosis in this city has been cut in half. Among females, the reduction has slackened since 1917 when, probably, in greater numbers they also entered into war work or into industrial establishments.

NEW YORK CITY — DEATHS FROM ALL FORMS OF TUBERCULOSIS IN EACH SEX, 1910 TO 1920

| Year | Number of Deaths | | | Death Rate per 100,000 | |
|---|---|---|---|---|---|
| | Males | Females | Per Cent. Males | Males | Females |
| 1910 | 6,352 | 3,722 | *63.1* | 266 | 155 |
| 1911 | 6,548 | 3,702 | *63.9* | 269 | 152 |
| 1912 | 6,465 | 3,516 | *64.8* | 261 | 142 |
| 1913 | 6,362 | 3,669 | *63.4* | 252 | 145 |
| 1914 | 6,716 | 3,574 | *65.3* | 262 | 139 |
| 1915 | 6,638 | 3,611 | *64.8* | 254 | 138 |
| 1916 | 6,185 | 3,463 | *64.1* | 233 | 130 |
| 1917 | 6,607 | 3,535 | *65.2* | 245 | 131 |
| 1918 | 6,318 | 3,780 | *62.6* | 231 | 137 |
| 1919 | 5,346 | 3,152 | *62.9* | 192 | 113 |
| 1920 | 4,211 | 2,924 | *59.0* | 149 | 103 |

In the study of the death rate of each year, it is interesting to note the variations, apart from the general reduction in both sexes. In 1914, among men, there was a rise not occurring among women. War is first of all a man's burden; and the effect of overtime work in 1917 is shown in the rise of the death rate from tuberculosis in that year among men. On the other hand, a rise only among women in 1918 might suggest that the influenza epidemic had its greater effect upon them. It is but necessary to recall the insufficiency of nursing assistance during the widely raging epidemic of that year to realize how much of the burden of the care of the sick must have fallen upon the women at home.

Looking at the apparently permanent and greater prevalence of tuberculosis among men in this city, the main difference in the habits of the two sexes must be studied if we are going to understand the cause of this difference and to develop measures for the prevention of the greater danger to men. Home conditions and food supplies are probably fairly the same, or at least comparable, among the two sexes. The main difference, then, lies in the workshop as against the home. Men, in much greater proportion than women, are at work outside the home — physical, laborious work is more their lot; and the lessening of the death toll among them will be achieved by improving, if possible, their special conditions of work. Overwork and unhygienic conditions in the shop, or in trades followed, are the special dangers that men are compelled to encounter.

One cannot help but wonder at the one-sided plan of attack against tuberculosis in the present development of dispensary work. The brunt of fighting the disease, or caring for those not in institutions in New York City, is carried on by these tuberculosis dispensaries. The reports of the Association of Tuberculosis Clinics of New York City, and those of the Department of Health, show that in 1920, alone, 146,054 visits were made by nurses for the education of patients and the prevention of disease. But all of these visits were made to homes. Each one of the nurses most carefully avoided places of work.

No criticism is to be made of the value of home work. The improvement of the home, where all spend quite a proportion of time, and where the protection of childhood demands it, is useful and necessary; but it does not begin to touch the correction of conditions which in a large measure are responsible for a death toll of over 67,000 boys and men in New York alone since 1910.

There are also dangerous conditions to be watched for in respect to the protection of women against tuberculosis, which are revealed by a closer study of the age at death of women in New York. There is a shifting of the crest of mortality, especially since 1917, among women, from older to younger age groups — namely, a change of the crest from 25–29 years to 20–24 years. It is at this latter age, especially, that a great number of girls leave home to work out. Attention to the conditions of work; understanding the vital need of taking sufficient rest and of eating sufficient lunches; taking care to wear sufficient clothing in inclement weather — all these are necessary if the increased danger to women is to be lessened.

Presence, Absence and Location of Râles in the Prognosis of Pulmonary Tuberculosis. *Francis B. Trudeau.* Jour. Am. Med. Assn., Oct. 22, 1921, 77, No. 17, 1326–1327. — Dr. Trudeau reports upon this question by means of an analysis of 1,000 consecutive admissions to the Trudeau Sanatorium during the years 1907 to 1913. The conclusions reached are:

"1. Cases in which no râles were found, either on admission or on discharge examination, show the highest percentage of 'cures.'

"2. Those patients who entered the institution with râles but who lost them during their stay form nearly as favorable a group as those showing no râles at any time.

"3. In patients who entered the institution without râles but who developed them during treatment, the prognosis is much more grave than in either of the two above-mentioned groups.

"4. In spite of the greater frequency and the more common findings of the tubercle bacilli in right upper lesions as contrasted with left upper, the prognosis is considerably more favorable in the former class of patients.

"5. Basal râles should not be diagnosed as nontuberculous too lightly, for in nearly 50 per cent. in our series, tubercle bacilli were found in the sputum, and nearly 40 per cent. of these developed apical râles during their stay in the sanatorium.

"6. The prognosis among our cases in which the râles were limited to one or both bases was not more grave than in those patients with râles over one or both upper lobes." — C. K. Drinker.

The Employment of the Tuberculous. *C. F. Rogers.* Pub. Health Nurse, Oct., 1921, 13, No. 10, 538-543. — Tuberculosis, by its nature, imposes upon workers affected by it certain conditions and limitations in respect to place of employment, physical conditions outside the shop, materials used in the work, and the general character of the work.

Formerly, physicians insisted upon outdoor work as the only suitable kind for the patient after treatment at a sanatorium, but now the necessity of compromise is often recognized, and experience has shown the non-harmful effects of indoor work under proper conditions for those who have previously been engaged in it. In some cases indoor work is not only permissible but preferable.

Distance to and from work must be considered for the tuberculous worker. Not more than forty minutes should be occupied in car-riding, and there should be no uphill walk at the end of the day.

High temperature in the shop, "or high temperature combined with a relatively high humidity" is to be avoided, and care must be taken in regard to the kind of materials and by-products with which the worker is brought into contact. Dusts which carry easily various germs, and those which come from emery and steel and may irritate or cut lung tissue; fumes in a japanning room; and poisons that may be inhaled are dangerous. Posture in the work must be looked after — work that requires a stooping position is bad. The eight-hour day and the forty-four hour week should be taken as a maximum at the beginning, and a shorter day is the ideal. What is needed is a series of tests "in which patients with given amounts of tuberculous infection and possessed of given amounts of muscular development would be compelled to perform certain shop tasks requiring the expenditure of specified amounts of muscular energy with a view to determining the amount of work a person who has reached a certain degree in the stage of recovering from tuberculosis can safely perform." The amount of nerve strain involved in the work must also be duly considered.

General intelligence, education, industrial training, the amount of financial remuneration demanded, individual preference, adaptability, temperament, age, sex, and sometimes race are factors that must be taken account of in placing the tuberculous worker. Financial considerations must be kept from dominating the situation, and sufficient relief from local charities should be called in to obviate this, if necessary. It is very important to direct the man to the very best situation for him, and his adaptability should be understood, so that he may, if it is advisable, be directed away from some preferred occupation in which there are obstacles not found in another.

The interests of both the individual and the industry must be considered. The employment agent has a precise problem to solve in finding a suitable position which the man is quite capable of filling, and "any employment agency which places its work on a semi-charitable basis rather than upon a foundation similar to that upon which all industry rests is doomed to ultimate disappointment."

Other conditions being favorable, the best position is the former task with the former employer, and the second best is a similar task in another industry or with another employer. — G. E. Partridge.

Prevention of Anthrax among Industrial Workers: Memorandum on the Disinfecting Station Established in Great

BRITAIN FOR DISINFECTION OF WOOL AND HAIR. His Majesty's Stationery Office, London, 1921, pp. 15. — A departmental committee of the Home Office was appointed to investigate the occurrence of anthrax among workers in wool and hair and in other industries. The report was that precautionary measures were not enough, and therefore an extensive experimental investigation was made as to the possibility of disinfecting wool on a commercial scale without injury to the material. A satisfactory method was devised, and it was recommended that compulsory disinfection of the raw material should be adopted. A trial station has been established and equipped, and the present paper is a detailed report of the method used and of the machinery employed.

Experiments showed that disinfection by any methods harmless to the material, in bales and even in fleeces, is always unreliable. A new method was therefore devised which comprises three processes: (1) exposure to an alkaline solution at a temperature of 102°F. for about thirty minutes; (2) exposure for twenty minutes to a 2½ per cent. solution for formaldehyde; (3) drying in a current of hot air. The machinery is so arranged that no handling of the material is required.

The remainder of the paper is given to a description of the engineering aspects of the problem. The plan and general arrangement of the trial disinfecting station are given, with drawings, and the construction and arrangement of the machinery are described, with especial reference to the automatic devices provided for eliminating handling. Everything is done by machinery from the time the untreated bales are opened until re-baling has been completed. Machinery is used also for sterilizing, washing and drying overalls worn by the workmen and the bale coverings taken from the original bales. Apparatus is under consideration also for purification of the formaldehyde solution for re-use.

A cubicle containing separate accommodation for overalls and ordinary clothing and a hot and cold shower bath is provided for each workman, besides ordinary lavatory basins in a separate lavatory. A list of items of the plant, with their cost, is given, and reference is made to Volume I of the report of the committee, in which the process of disinfection is fully described. — G. E. Partridge.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

AN OCCUPATIONAL DERMATOCONIOSIS AMONG ZINC OXIDE WORKERS. *John A. Turner.* U. S. Pub. Health Service, Pub. Health Rep., Nov. 4, 1921, 36, No. 44, 2727–2732. — The author describes the condition he observed as follows:

"The zinc oxide, body débris, and bacteria are forced into the sebaceous glands, distending them. This action is aided by free perspiration, and the rubbing together of two body surfaces. It is probable that the presence of the foreign substances, acting as a mechanical block to the outlet of the glands, and the increased tension due to the retained secretion, produce sufficient irritation of the gland walls to allow an invasion of the bacteria and a resulting infection.

"The disease occurs most frequently during the summer months, and to a lesser degree during the winter months. The consensus of opinion among the workmen is that the occurrence of the disease depends entirely upon personal cleanliness, and that if they take daily baths no trouble is experienced."

He thus makes it clear that this skin condition does not depend upon any poisonous property of zinc but upon the fineness of the oxide dust and its consequent ability to enter and plug sebaceous glands. Protective clothing and cleanliness constitute the obvious remedies. If viewed thoughtlessly, the report seems to add another count to the problem of the toxicity of zinc, but this it does not do, nor do we as yet have reliable evidence that this metal has specific poisonous properties either superficially or internally. Even the widely accepted contention that zinc is the offender in brass casting still lacks confirmation in terms of unimpeachable evidence and readers should not overinterpret the observations submitted in this pamphlet. — C. K. Drinker.

MATCH BOX DERMATITIS AND CONJUNCTIVITIS. *C. Rasch.* Abstracted as follows from Ugeskrift for Laeger, Aug. 25, 1921, 83, No. 34, 1119, in Jour. Am. Med. Assn., Oct. 15, 1921, 77, No. 16, 1296. — "Rasch has encountered

thirteen new cases of dermatitis from carrying or handling a box of safety matches, and relates that one of the more recent cases was quite severe, the dermatitis on fingers, neck and face lasting for two weeks and being accompanied by severe conjunctivitis, the eyelids swollen together. The aspect and course is like that with poisoning from *Primula obconica*. The matches were all of Swedish make with the trade mark of a ship, and the poisoning is ascribed to the phosphorus sesquisulphid ($P_4S_3$) used in them when amorphous phosphorus could not be obtained. In men the dermatitis generally corresponds to the trousers pocket, but women who smoke a great deal and use many matches are affected in the fingers and conjunctiva." — C. K. Drinker.

Sclerodactylia. *J. H. Sequeira.* Abstracted as follows from Proc. Roy. Soc., July, 1921, Vol. 14, 75, in Arch. Dermat. and Syph., Nov., 1921, 4, No. 5, 708. — "A woman, a machinist, aged 50, who gave a history of numerous whitlows in early life, had noticed swelling of the hands two months before presentation. The swelling persisted about a month and then disappeared spontaneously, leaving the fingers stiff. The skin over the hands, wrists and fingers was hard and fixed. Isolated sclerodermatous lesions were present on the forearms and chest." — M. C. Shorley.

Dermatitis among Workers in Phenol Resins. *O. Sachs.* Abstracted as follows from Wien. klin. Wchnschr., July 21, 1921, 34, No. 29, 356, in Jour. Am. Med. Assn., Oct. 8, 1921, 77, No. 15, 1216. — "Sachs warns that in view of the increased manufacture of artificial amber or phenol resins (bakelite) great precautions should be taken to prevent the development of dermatitis. In the process of manufacture the fumes of phenol, formaldehyd and ammonia escape into the room. In several patients observed by Sachs, the dermatitis was localized on the face, forearms and hands. Many of the patients presented also a conjunctivitis and several, bronchitis. The dermatitis was accompanied by intense reddening, some swelling and exudation, and was of a severe type in most of the cases. The patients were all women, as no men were employed in the factory. Nearly all the employees were affected. Treatment consisted in the application of Burow's solution. After the acute manifestations disappeared, a bandage with an ointment of 3 per cent. boric acid in rectified wool fat on Lassar's zinc paste was applied. The course of treatment extended, on the average, over from four to six weeks. Many patients changed their employment rather than expose themselves again to the inconveniences. It is the duty of factory inspectors to see to it that the necessary ventilation apparatus is installed and that other precautionary measures are taken. This artificial amber is used in making billiard balls, buttons, etc. Some of the employees had protected themselves by smearing the face with petrolatum." — C. K. Drinker.

A Case of Bullous Eruption Caused by May-Weed. *J. H. Sequeira.* Lancet, Sept. 10, 1921, 2, No. 11, 560. — A strong, healthy woman, aged 51, presented herself at the London Hospital with a remarkable eruption of blebs on the left elbow and both wrists. She had been engaged in picking peas in Essex.

The eruption came on acutely three days previously. The blister on the elbow was enormous, irregular and flaccid. It extended down the back of the forearm for 3½ to 4 inches. A similar bleb 3 inches by 2 inches was present over the ulnar aspect of the back of the left wrist, and a rather larger bulla on the same position of the right wrist. The fluid in the blebs was clear; there was no zone of redness around them. The patient complained of pain and some irritation. She ascribed the lesions to poisoning with May-weed, a common field weed. Abrasions, produced by her occupation of pea picking, apparently preceded the lesions. She described other cases among workers similarly employed. Sequeira, on making inquiries in South Essex and Kent, obtained the histories of other cases in which individuals had been obliged to give up work for some weeks. — R. Prosser White.

Dermatitis Venenata Caused by the Oak. *M. L. Spillmann.* Bull. de Dermat. et de Syph., 1921, No. 6, p. 33. — In the month of February a laborer was engaged near Toul in France in carrying on his right shoulder the wet branches of a recently felled oak tree (*Quercus robur*). The same evening the right cheek, ear and both hands felt painful and smarted. Next day these parts were red, swollen and intensely itchy. A few hours later the whole of the genital region developed an identical eruption in which exudation and crusting were prominent features. Under treatment the man was

cured in twelve days. The man's grandfather, one of his uncles, and some of the villagers are known to have suffered in exactly the same way when manipulating freshly cut oak.

The writer is able to exclude ivy, *primula euphorbia*, etc., as possible causes of this dermatosis. He is uncertain whether the juice of the oak bark, or some vegetable growth on the bark was responsible for the condition. He believes this to be the first reported instance of oak bark dermatitis. — R. Prosser White.

Skin Lesions in Briquette-Makers and their Relation to War-Melanoses. *Rudolf Schürer.* Schweiz. med. Wchnschr., March 31, 1921, 51, No. 13, 296–299. — The lesions consisted in:

1. Diffuse dark to red-brown pigmentation, especially in places where the skin was exposed to light or to the pressure of clothes (waist and axilla). The conjunctivae were dirty brown, particularly at the palpebral fissures.
2. Hyperkeratoses, with comedones.
3. An eruption of acneform efflorescence at all stages of development.
4. Epithelial proliferation at circumscribed spots.

The cause in all cases was undoubtedly exposure to tar and its products. The author concludes, after careful histological study, that these lesions are the same as the so-called war-melanoses. The condition cleared up gradually with resorcin (3 to 6 per cent.) and Lassar's paste. — H. G. Noyes.

Ocular Nystagmus and Railroad Nystagmus. *R. Bárány.* Abstracted as follows from Upsala Läkareförenings Förhandlingar, Sept. 1, 1921, 26, No. 5–6, in Jour. Am. Med. Assn., Oct. 29, 1921, 77, No. 18, 1457.— "Bárány offers here an explanation of the phenomenon observed by him of nystagmus in an abnormal direction in testing for 'railroad nystagmus.'" — C. K. Drinker.

Preventable Vocational Eye Injuries. *William B. White.* New Orleans Med. and Surg. Jour., Aug., 1921, 74, No. 2, 126. — This paper reviews the advances made in the direction of eye protection, and various statistics proving the need for more stringent laws, and gives the nine rules promulgated by the Bureau of Standards in its code for the protection of the head and eyes of industrial workers. The objections made by employees to the wearing of goggles are cited, but the author believes that the responsibility for the enforcing of the National Safety Code belongs to a certain extent "to the general practitioner." — M. Dent.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Safety in the Factory. *E. L. M. Franklin.* Indust. Management, Sept. 1, 1921, 62, No. 3, 159–160. — This article contains helpful suggestions from several companies for various improvements around the factory. These are, in brief:

Glass shields placed between the man and his work are in many instances better than goggles. They can be tinted when the prevention of glare is necessary, and can be made of fire glass which has wire mesh embedded in it so that if it cracks the pieces will not fly.

Gears, encased in woven wire guards which are reinforced and are so strong that a man falling against them will not cause them to cave in, are used in one factory. Another adds two little feet beneath each ladder which absolutely prevent it from slipping. Another plant finds it useful to provide separate exits for women workers so that they will not be crowded and crushed by the men at the noon hour or at closing time. This same company runs the freight elevator for a quarter of an hour before starting time, and again at noon for the benefit of women employees. At no other times are the elevators used for employees. — M. Dent.

Education in Safety Engineering as Given at the Lynn General Electric Engineering and Apprentice School. *N. M. DuChemin.* Safety Engin., Sept., 1921, 42, No. 3, 106–112. — This article is an outline of ten lectures given at the Lynn School and adjusted to plant conditions of the Lynn General Electric Company. The lectures are on:

1. Explanation of the introduction of the Workmen's Compensation Acts in European countries and the United States, and also of industrial insurance.

2. Fire prevention.
3. Safety in the boiler room and power station.
4. Power transmission.
5. Wood-working machinery.
6. Metal-working machinery.
7. Plant equipment.
8. Organization.
9. Advertising.
10. Selling safety. — R. M. Thomson.

What Are the Dangerous Jobs? *James A. Tobey.* Safety Engin., Sept., 1921, 42, No. 3, 102–105. — This article gives in two figures and a table the number of persons killed in the United States during 1918 by industries, the total number of accidental deaths in 1918 in the United States, and industrial accidental deaths during 1918. Coal and metal mining, navigation, fisheries, electricians, steam and street railways lead the list of the most dangerous industries. During 1918 accidental deaths constituted 4.6 per cent. of deaths from all causes in the United States.

The author concludes with a plea for more and even more intensive accident prevention work. "The control of accidents is one of the big problems of our energetic American life. It is one that must be faced and faced now." — M. Dent.

Advertise Prone Pressure Resuscitation. *Charles H. Lauffer.* Nation's Health, Sept. 15, 1921, 3, No. 9, 519–521. — Dr. Lauffer first emphasizes the necessity of advertising more widely the advantages and the exact technic of the prone-pressure method of artificial respiration, the method which is believed by the best authorities to be the most efficient manual method of resuscitation, and to be superior to any commercial mechanical apparatus yet devised for giving artificial respiration. The advantages of the prone-pressure method are summarized as follows:

"1. Prone pressure is a one-man method. It is easy to learn and easy to apply. Under proper technic, one person can keep it up an hour without undue fatigue. A single operator, alone and unassisted, with no devices other than his hands, and with no assistance from any other instructed person, can successfully resuscitate the victim of accidental drowning, gas asphyxiation, electric shock, or other condition requiring immediate efforts at artificial respiration.

"2. No time is lost hunting up mechanical devices, in which the persons applying them may be unskilled, or which may not be in working condition. . . .

"3. Even if a serviceable mechanical device can be obtained, it may not be immediately available. It is unfair to the prone pressure method to say that the mechanical device has resuscitated the victim, when the victim has been kept going by the manual method, and is practically resuscitated before mechanical devices reach the scene.

"4. The manual method elevates the diaphragm, pumps venous blood from the liver and splanchnic area to the heart — which is empty in electric shock — and, by distending the heart and blood vessels by the massage of these parts, it aids in the restoration of circulation. As is well known, in electric shock the heart action may be suspended before respiration is arrested, consequently the manual method, by stimulating cardiac function, holds out the greater prospect of restoring animation in the victim of electric shock.

"5. The use of mechanical devices of the bellows type requires a degree of pressure to inflate the lungs, and a degree of suction to empty the lungs, that is incompatible with normal physiologic breathing. In other words, the mechanical devices are the more liable to do violence to the pulmonary tissues than are manual methods. The manual methods more closely imitate nature.

"6. The water in the lungs encountered in drowning, and the edema of the lungs encountered in electric shock, and occasionally observed in asphyxiation by gases, require that the patient be in a prone position. The prone position not only facilitates the removal of liquids from the lungs and air passages, but it permits the tongue to gravitate forward, thereby making it possible for one man, alone and unassisted, to resuscitate a comrade in distress."

Dr. Lauffer next discusses in detail faults of technic which may lead to failure of resuscitation and which bring unwarranted discredit on the prone-pressure method, and concludes with an enumeration of non-essential points of divergence in technic. — Katherine R. Drinker.

How Accidents Are Reduced in an Oil Refinery. *E. C. Esterly.* Nat. Safety News, Aug., 1921, 4, No. 2, 28–29. — The conditions in the works of the Atlantic Refinery Company

of Philadelphia are somewhat unusual, the shops and various departments being located at distances from each other; hence a different sort of safety department was organized, consisting of seven inspectors. A daily system of inspection was laid out which covers every inch of the plants. Conditions which should be remedied are reported to the superintendents of the various departments for criticism and action.

The safety department maintains a small shop for the manufacturing of guards for machinery. It makes an analysis of the most prolific sources of accidents and concentrates its efforts on those causes. In order to cope with fatalities from asphyxiating gases 200 employees were trained in the use of self-contained oxygen rescue apparatus, and in the practice of the Schäfer prone-pressure method of resuscitation. A few employees were taken for this training from each department and each shift, so that some men will always be on duty who are trained in that particular branch of rescue work.

The number of guards installed, repaired, departments inspected, etc., is given in order to show in more detail what the safety department has done for the plant. — M. Dent.

Safety Hook Prevents Mine Car Grade Accidents. Nat. Safety News, Sept., 1921, 4, No. 3, 30. — This is a brief illustrated description of the Buck Safety Hook and of its use on mine cars to prevent them from running away down the steep grade in case the cable breaks. — M. C. Shorley.

Metal-Mine Accidents in the United States during the Calendar Year 1919. *William W. Adams.* U. S. Bur. Mines, Tech. Paper 286, 1921, pp. 99. — This report covers copper mines, gold, silver and miscellaneous metal mines, iron, lead and zinc, and nonmetallic mineral mines. It represents 3,383 mine operators employing 145,262 men for an average of 281 days each. "The reports for 1919 show that for every thousand men employed during a full-time year of 300 working days, 3.43 men were killed and 231.18 men were injured, an injury signifying disability for at least one day. The fatality rate was the lowest on record for the metal-mining industry in the United States, and the injury rate was lower than for any year since 1914." — M. Dent.

Coal-Mine Fatalities in the United States, 1920. *William W. Adams.* U. S. Bur. Mines, Tech. Paper 288, 1921, pp. 112. — "According to reports received by the United States Bureau of Mines from the various state mine inspectors, 2,260 men were killed by accidents at coal mines during the calendar year 1920, a decrease of 57 fatalities from the record of the year before. This reduction in the number of lives lost is particularly gratifying because it was accompanied by an increase of more than 18 per cent. in the output of coal. . . . Considered by causes, there was a decrease of 64 per cent. in fatalities due to mine fires, 38 per cent. in fatal accidents caused by explosives, and 14 per cent. in deaths resulting from explosions of gas and coal dust. There was also a decrease of 16 per cent. in haulage accidents above ground. An increase of 10 per cent. is noted in the underground accidents due to electricity, 6 per cent. in fatalities caused by underground haulage, and about 2.5 per cent. in deaths caused by falls of roof and coal." — M. Dent.

Accidents in Mines and Quarries of the United Kingdom in 1920. U. S. Bur. Labor Statis., Month. Labor Rev., Sept., 1921, 13, No. 3, 658. — "The report of the Mines Department of the British Board of Trade (*Part I. — Divisional Statistics*) gives detailed statistics of accidents in mines and quarries of Great Britain and Ireland (in the case of metalliferous mines and quarries, including also the Isle of Man) during 1920." A summary of these figures is given in a table. — M. Dent.

An Explosion of Hard Rubber Dust. *David J. Price* and *Hylton R. Brown.* Abstracted as follows from Chem. Met. Eng., 1921, Vol. 24, 737–740, in Chem. Abstr., July 20, 1921, 15, No. 14, 2358. — "Although not heretofore considered as such, hard rubber dust is combustible and forms explosive mixtures with air. This accident, through which 8 were killed, 4 injured and property valued at $25,000 destroyed, occurred in the course of reduction of hard rubber to dust by grinding for re-use. The circumstances and precise cause of the accident were not definitely determined, but a set of recommendations covering possible causes is offered."

A Recently Developed Dust Explosion and Fire Hazard. *David J. Price* and *Hylton R. Brown.* Abstracted as follows from U. S.

Dept. Agri., Circular 171, 1921, pp. 7, in Chem. Abstr., July 20, 1921, 15, No. 14, 2356. — "This deals with explosions of dust-air mixtures ignited by incandescent electric lamps, either from the dust accumulated on the bulb becoming heated to incandescence or from dust clouds becoming ignited when the bulb of a glowing incandescent electric lamp was broken. A description, with drawings, of the method devised for testing the latter is given and explosions of dust-air were obtained with both vacuum and gas-filled lamps, except vacuum tungsten and carbon lamps of very low wattage. *All electric lamps in places where inflammable and combustible dust exist should be equipped with vapor-proof globes, protected by heavy guards to prevent breakage.*"

Administrative Methods for Technical Supervision of the Paper Working Unions. *R. Hütt.* Zentralbl. f. Gewerbehyg., Aug., 1921, 9, No. 8, 177–180. — This article gives a detailed description of office methods for classification of accidents from all standpoints, and examples of the results obtained by such methods. — E. L. Sevringhaus.

Safety-Trip for Punch Presses. *C. E. Wildoner.* Safety Engin., Aug., 1921, 42, No. 2, 61–62. — A simple safety trip arrangement for punch presses accompanied by illustrations. The device is not patented, and has the advantages of low cost and easy installation. — R. M. Thomson.

## INDUSTRIAL SURGERY

Observations Based on a Study of Injuries to Elbow. *I. Cohn.* Abstracted as follows from Arch. Surg., Sept., 1921, 3, No. 2, 357, in Jour. Am. Med. Assn., Sept. 24, 1921, 77, No. 13, 1047. — "Cohn is of the opinion that three things are necessary in the treatment of fractures: a clear knowledge of the normal on the part of the roentgenologist; a more careful examination of the patient, to eliminate unnecessary work, and; last, a closer co-operation between the roentgenologist and surgeon which will prove helpful to all. A suggestion from the roentgenologist that, as a result of his study of the picture, he would make a prognosis of a deformity if the fracture is allowed to remain in the position that it was in when the patient was sent to him, will prevent many future disabilities and deformities." — C. K. Drinker.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

The Heart during Physical Exercise. *Boigey.* Abstracted as follows from Presse méd., Aug. 17, 1921, 29, No. 66, 654, in Jour. Am. Med. Assn., Oct. 1, 1921, 77, No. 14, 1137. — "Boigey is the physician in charge of the Ecole d' éducation physique at Joinville. His numerous tests have demonstrated that a phase of relaxation and passive distention follows when the first phase of hypertonicity — which accompanies every physical effort — is past. The exercise should never be allowed to progress as far as this second phase." — C. K. Drinker.

Histologic Changes in the Kidney Produced by Chilling. *Cicconardi.* Abstracted from the Arch. p. le sc. med., Vol. 43, No. 5–6, in Il Lavoro, Aug. 31, 1921, 12, No. 4, 106–107. — The author applied to rabbits a freezing mixture over the left lumbar region; a rubber ice bag directly on the exposed kidney; immersion of the whole animal in ice water until there was a decided fall of body temperature. The kidneys in certain of the experiments were stained during life by intravenous injection of a solution of lithium carmine. The conclusions obtained from eighteen experiments are as follows: The effect of cold on the kidneys of rabbits is to produce alteration of function as shown by albuminuria and the production of granular casts. Histologically the changes consist in modification of the reaction to vital stain with carmine, the presence of desquamated epithelium in the tubules, degenerative changes and hemorrhagic infiltration. These changes appear during the first twenty-four hours after the action of the cold, diminish during the following days, and disappear with complete

restitution of integrum in about two weeks. When the cold was applied to one kidney only, the other also underwent these changes and general immersion of the body in cold water was productive of more serious lesions than the local application of cold — sometimes even a true hemorrhagic nephritis resulted. The fact that the real alterations disappear so rapidly seems to show that cold cannot be considered as the cause of incurable nephritis. — Alice Hamilton.

Practical Methods of Fatigue Elimination. *Frank B. Gilbreth.* Nation's Health, Sept. 15, 1921, 3, No. 9, 523–525.—This article deals with the organization and functions of the Committee for the Elimination of Unnecessary Fatigue. Its membership is drawn from many and diverse fields of activity: research workers in medicine, in psychology, in physiology and in psychiatry; economists, statisticians, educators, etc. It is the object of the committee to investigate fatigue conditions in all parts of the world in all industries having fatigue problems. Up to the present time the work of the committee has consisted in arousing interest and surveying present practice and in showing what has actually been done in fatigue elimination and its study. Many suggestions are herein made respecting the future activities of the committee, chief of which will be the establishment of fatigue elimination standards, which are predicted to add to the comfort and happiness of all workers. — L. A. Shaw.

## HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

Rupture of Large Intestine from Compressed Air. *G. Jean.* Abstracted as follows from Presse méd., Aug. 24, 1921, 29, No. 68, 675, in Jour. Am. Med. Assn., Oct. 1, 1921, 77, No. 14, 1137. — "Jean reports two cases of this kind with recovery of both patients after resection of the severely damaged and ruptured bowel and the making of a definitive median abdominal anus. The injury was from the bursting of a pipe conveying condensed air or a jet from the nozzle. In both cases the pipe had been 10 or 20 cm. from the skin." — C. K. Drinker.

Safety Features in High Tension Generating Stations and Substations. *M. M. Samuels.* Safety Engin., Sept., 1921, 42, No. 3, 112–115. — This article deals with safety features in substation design, safeguarding transformers and generators, lightning arresters and bus structures, improvements in safety devices, need of signal lamps, rigid bus outdoor substations and illumination of stations. The best design for all these features and for stations in general is a simple one. — R. M. Thomson.

## WOMEN AND CHILDREN IN INDUSTRY

The Employment of Women in 5 and 10 Cent Stores. New York State Dept. Labor, Special Bull. No. 109, Sept., 1921, pp. 68. — Seventeen cities, besides New York and Brooklyn, and a total of seventy stores, sixty of them under chain management, were included in this investigation. The plan and general policy of the stores are described and the various requirements made of employees, wages, etc., are recorded. Data are presented in respect to 2,626 employees, of whom 2,325 are women. Thirty per cent. of the total number of women were working on a part-time basis, and among these there were many school girls — in New York City one-fourth of the part-time workers being of this class.

As to physical conditions of work, fourteen of the stores had a main floor and basement, and in some cases ventilation in the basement was poor. Most of the stores had drop seats behind the counters. Nine stores had special drinking water stands or bubblers. Toilet facilities were fairly good, although "the basement wash- and toilet-rooms, which were found in 21 stores, were poorly lighted and ill-ventilated places." Seven establishments provided a common roller towel. Ten provided no rest room. Seventeen of the rest rooms were in the basements, many of them poorly ventilated. Twenty-nine stores had rest rooms above the main floor. One chain had made an effort as a management policy to see to it that employees had not only sanitary but also comfortable rest rooms.

The regular working hours of 98 per cent. of

the women were less than the legal maximum, which is fifty-four hours a week. Of the seventy stores, twelve closed every day, except Saturday, at 5.30 P.M., and fifty-five closed at 6.00 P.M. The closing time of forty-nine stores on Saturday was 9.00 P.M. or later, twenty-one keeping open until 10 P.M. Sixteen per cent. of the women were found to be working eleven hours on Saturday. No store had regular rest times for its employees, except during the meal hours. In some cases, where there was a heavy noon trade, some of the workers were obliged to go to the mid-day meal as early as 10.45 A.M.

Of all the full-time women workers, one-half received less than \$13.49 a week, and two-thirds less than \$15.00. Of the whole number of full-time women workers, 1,298 were sales clerks, receiving a "flat wage." The largest group of saleswomen received \$12.56, and half received less than \$12.91. A very large percentage of the salaries paid fall below the minimum standards of cost of living for New York, according to available figures.

Some other topics are mentioned, for example, food handling by the 5 and 10 cent stores, a subject which apparently needs further attention. The paper contains nineteen charts and tables. — G. E. Partridge.

THE RELATION OF CHILD LABOUR TO CHILD HEALTH. *Arthur Butler Chandler.* Pub. Health Jour., Sept., 1921, 12, No. 9, 397–401. — We must not lay too much stress on the physiologic damages wrought by child labor, for even without these the mental and moral effect of child labor is bad enough to warrant its prohibition. It must be remembered that a child is in "process of constant physical formation" and variety in his daily life is necessary.

"Fourteen years must be the minimum for all kinds of employment, including farm labour and domestic service. Sixteen years should be the minimum where the work entails any hazard, and eighteen years for those occupations which are extra hazardous."

Forbidden occupations should include the following:

"1. Processes involving exposure to poisonous dust, *e. g.*, the manufacture of paint or plumbing supplies, typesetting, file-cutting, certain occupations in the manufacture of rubber and storage batteries.

"2. Processes involving exposure to irritant dust, *e. g.*, (1) graphite dust as used in stove polish; (2) bronzing in lithographing; (3) cutting, grinding or polishing with emery; (4) talc dusting in rubber works; (5) sorting, dusting, cutting or grinding rags; (6) all work in and about mines.

"3. Processes involving exposure to poisonous gases and fumes, *e. g.*, using naphtha in the manufacture of rubber goods, japanned or patent leather; gases from lead processes.

"4. Irritating gases and fumes, *e. g.*, (1) gassing in textile factories; (2) singeing in print works, bleaching and dyeing works; (3) dipping metal in acid solution.

"5. Exposure to extremes of heat and other conditions which promote susceptibility to disease.

"A glance at our school children only serves to strengthen the case against child labour. There is no disputing the fact that 25½ per cent. of all school children are suffering from malnutrition. . . . As the worst school is safer for the child than the best factory one might well indict all child labour as being unfit for a child." — M. Dent.

THE INTERNATIONAL LABOUR OFFICE AND THE PROTECTION OF CHILDREN. Internat. Labour Rev., July–August, 1921, 3, Nos. 1–2, 3–25. — This article contains, for the most part, historical data in regard to the protection of children in industry, brought together especially with reference to the protection of child labor by the International Labour Office, under whose jurisdiction this problem is plainly thought to come. An account is given of the work of the first International Labour Conference which was held at Berlin in 1890, and of the conference at Zürich in 1912.

The Paris Conference for the preparation of the Peace Treaty, in January, 1919, set up a commission especially entrusted with preparing the articles of the treaty dealing with labor problems, and the Preamble of Part XIII provides for the protection of children, young persons and women. The agenda of the first International Labour Conference following the war, that of October, 1919, included several items relating to children and similar consideration of the problem of the protection of motherhood. Three questions were brought up: minimum age for industrial employment; night work; and unhealthy work. The Washington Conference decided unanimously to place the age limit at 14 years, India being made an exception. The minimum age for night work was fixed at 18 years, although exceptions were

allowed to Japan and India. Since complete information was lacking on the subject of unhealthy employments, nothing further was done than to ask for the prohibition of employment of women and young persons under 18 in a number of occupations employing lead and lead compounds.

The history of national action upon the recommendations, etc., of the conference is given briefly. There is a record of the decision of the conference to refer problems of work at sea to a special conference, and information is given in regard to the treatment of these problems up to the present.

The notable advance in international legislation, the wide area over which recommendations are now operative, and the reciprocal treatment granted between states are commented on. — G. E. Partridge.

Enforcement of Child Labor Laws in West Virginia. *Ethel H. Van Buskirk.* Am. Child, Aug., 1921, 3, No. 2, 123–151. — This is a report of an investigation carried on in eight cities of West Virginia, during which the records of 2,780 children were examined, and about 200 children interviewed.

During the first eighteen months of the operation of the law (May 11, 1919 to November 30, 1920), about 3,900 children between the ages of 12 and 16 received permits to go to work. The chief industries employing children are the glass, pottery, laundry, furniture and woodcarving, cigar, cigarette, stogie or some branch of the tobacco industry, stamping, tool and sanitary works, telegraph companies, department stores, markets, bowling alleys, restaurants, printing offices, and shoe shining parlors. In general, children are engaged in mechanical and automatic work.

Investigation as to the extent to which the regulations of state and federal law were carried out showed that the weakest point is in respect to physical fitness for a specified occupation. In some places physical examination was omitted entirely, and physicians complain that there are no standards and no way of knowing the character of a child's prospective employment or environment. There was found conflict of legal responsibility, and confusion, especially in the matter of special permits; a curious situation existed, due to the fact that children under 14 may be allowed to work during the school term after school hours, who cannot legally work during the summer vacation.

Of the 200 children interviewed, only thirty-eight were actually working legally — that is, had met the requirements for a permit and were working in accordance with both federal and state laws. Violations were of various kinds, but the most serious and frequent were in cases in which children between 12 and 16 years of age were working in forbidden industries or were working overtime.

Several recommendations are made for improving the situation: strict supervision of local permit-issuing offices by inspectors; appointment of additional labor inspectors, one of whom should be a woman; establishment of standards of health fitness; drastic prosecutions for employing children under 12 years of age and for employing children between 12 and 16 years more than eight hours a day or in night work. It is also recommended that special permits for boys under 14 be abolished, a penalty established for non-attendance at school of children between 14 and 16, and a penalty for violating the law (to be effective in July, 1922) compelling the establishment of part-time schools or classes. — G. E. Partridge.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Paint as an Accident Reducer. *Gardner Tillinghast.* Safety Engin., Aug., 1921, 42, No. 2, 59–60. — From insurance figures, the imperfect light through poor diffusion from walls and ceilings not painted white is the cause of numerous industrial accidents. A workman fatigued because of poor light is more careless, and statistics show that the majority of accidents occur then. Managers and owners realize the advantage of white paint on ceilings and walls as a light reflector in reducing accidents, creating contentment and doing away with the greatest enemy of the inside workman — factory fatigue, the indirect cause of many accidents otherwise classified. — R. M. Thomson.

The Eye Is Mightier than the Hand. *Archibald C. Reid.* Safety Engin., Aug., 1921, 42, No. 2, 58–59. — This short article deals with

the advantage of good lighting and painting in modern establishments. Brighter surroundings given by proper lighting and suitable coatings for floors, walls, ceilings and equipment, will relieve eyestrain and increase the efficiency and morale of employees. — R. M. Thomson.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

THE CONSULTANT IN INDUSTRIAL MEDICAL SERVICE. *Wade Wright.* Nation's Health, Sept. 15, 1921, 3, No. 9, 508–509. — "Industrial health is so nearly identical with public health that it would seem as if industrial hygiene were properly a unit of the community health service. The fact remains, however, that in few communities has medical organization developed efficient means of recognizing and promptly treating incipient disease. If such service is desired in industry, industry must provide it.

"The character of a community is governed largely by industrial conditions and through such means as the physical examination of labor, the periodic re-examination of employees . . . the development of good will and confidence of workers in the medical department and the consequent appeal for the advice of the plant physician, . . . are afforded unlimited opportunities for constructive health work.

"Service of this character can only be rendered by able personnel and it is economic folly for the administration of an industrial organization to believe that practically any doctor or any nurse can be depended upon to do work of a satisfactorily high standard. The interests of successful industrial physicians and nurses cannot be their own interests or the company's interests, but rather a just mingling of the company's interests with those of the patients who come to them for professional service. . . . Competent physicians cannot be secured unless their compensation be roughly commensurate with their worth.

"Good industrial medical service is not to be had cheaply, yet it seems that it is worth what it costs and more, for ill health is so costly. . . . Establishments installing medical service do not abandon it. They may reduce it in times of depression, but the tendency is almost invariably toward development, toward an increase in the range of health department activities." — Katherine R. Drinker.

PRODUCTION MANAGER'S INTEREST IN INDUSTRIAL HEALTH. *J. Spence.* Nation's Health, Sept. 15, 1921, 3, No. 9, 506–507. — In the general business retrenchment, the shop doctor and the hospital will be closely examined to prove their value. Experience has shown that they are important parts of the industrial organization. Industrial medical service has done more than introduce sanitary treatment of injuries; it has also played an important part in promoting the proper shop spirit. To be successful, a plant physician must have ability as an organizer and leader; otherwise he will not be able to enlist the co-operation of foremen in furthering plans for the execution of which the foreman's sympathy is essential. In general, paternalism is not good in industry, but re-examination of men who are failing, investigation of absenteeism and advice when needed are desirable.

Departments having to do with sanitation, safety and health are so closely related that when the right medical director can be found, they should come under the same head. Moreover, the director should be concerned with welfare work and bettering living conditions in general. The medical service pays for itself in productive hours and in the saving of turnover, and it is especially useful in the preservation of the health of important men who are valuable and who, because of great skill and expert knowledge, cannot be spared.

The attitude of the shop doctor necessarily is different from that of the private practitioner. He is able to follow up his cases more thoroughly and he is affected by the spirit of co-operation. Figures (for the Norton Grinding Company) show that the entire cost of hospital work is only three-tenths per capita of what is paid for shop cleaning. "Both are necessary, and both in the long run pay dividends." — G. E. Partridge.

PRACTICES AND FUNCTIONS OF THE MEDICAL DEPARTMENT. *Robert E. Andrews.* Indust. Management, Oct., 1921, 62, No. 4, 206–211. — Dr. Andrews gives a very detailed outline of the highly organized medical department of the Ludlow Manufacturing Associates, where the routine procedure is worked out to the minutest

detail. Each applicant for employment is given a physical examination by the physician to determine whether he is:

"(1*a*) Fitted for any but a dusty job.

"(1*b*) Fitted for any but a wet job.

"(1*c*) Fitted for any but a weight-lifting job."

All the data from this examination are carefully filed away and are used for comparison with later health records of the particular individual, thus "serving as a basis for the study of the effect of the job" on his health.

Surgical cases are given free treatment, either hospital, consulting or special treatment. Consultation cases, common medical and surgical supplies are free; glasses are furnished at cost.

A system of passes and cards has been worked out to prevent malingering and loafing of the employee between the mill and the clinic. Cards are made out by the foreman with the time the employee left the mill stated thereon, and must be presented on his arrival at the clinic. Until the foreman receives notice from the clinic he continues to send that particular employee to the clinic regularly for treatment. Passes to leave the grounds must be applied for to the physician by the employee desiring them. Wages are paid to employees taking time off to attend the medical clinic, and to those sent home on account of sickness or injury up to the time the pass is issued to go home.

A convenient first-aid room, with only sufficient equipment for first aid and redressings, is maintained in a plant which is too far away from the regular clinic. In the same mill a rest room is provided for women employees. There is also a prenatal clinic for the entire plant. No woman is allowed to work beyond the seventh month.

"The most important problems which the plant physician has had to meet "are not those of consultation and treatment, but of gaining the co-operation of all the other departments of the plant. This has been undertaken with the ultimate aim of more efficient and increased production at lower cost, through the service of the medical department. It has been essential to arrange that employees at all times have easy access to the clinic. All red tape and paper work have been reduced as far as possible. Tactful, friendly, helpful relationships have been instituted, based on a study of the characteristics and mental attitude of the employees, especially of the foreign born." — M. Dent.

St. Louis Southwestern Railway Medical Service. *A. E. Chace.* Nation's Health, Sept. 15, 1921, 3, No. 9, 515–518. — The medical service of the St. Louis Southwestern Railway is one of the oldest industrial medical organizations in the country, having been founded in 1887. At the present time 10,000 employees are provided for, and to meet the increasing demands a new hospital has been built with a capacity for treating 200 patients. Besides the central hospital the railway maintains fifteen emergency stations and eighty part-time physicians. All baggage cars are provided with cots or stretchers, and first-aid material is kept ready for distribution.

Funds for the support of the medical department are derived from two sources — the company, which provides for the capital expenses and any deficit in running expenses, and the employees, who contribute funds for operation, on a basis of salary earned. The right of employees as regards the service are clearly defined, and the work is systematically regulated.

There is a sanitary engineer, with a corps of assistants, reporting directly to the president and having charge of such work as malaria control, water supplies, sanitation and inspection. A superintendent of safety, reporting to the vice-president in charge of operation, has oversight in the shops and on the line.

Examination of applicants is thorough and complex. It involves job analysis, psychological tests, estimation of moral risk, complete records, advice, and follow-up work. Re-examination is made every three months of food handlers and of those whom it is thought necessary to watch. Venereal cases are treated free at the hospital, and are subjected to special rules. Most dental work is also free.

"This medical department is in the stage of transition from the better class of medical and surgical work in industry to the highly technical combination which we all hope will be better appreciated by all industry in the near future." — G. E. Partridge.

The Medical Department Proves its Value. *J. A. Robertson.* Nation's Health, Sept. 15, 1921, 3, No. 9, 509–510. — In this article Mr. Robertson, the manager of the Camera Works of the Eastman Kodak Company, sketches briefly the introduction into and the development of the industrial medical service in the company. First came a safety committee, next a part-time, then a full-time

doctor, next additional doctors, nurses and attendants, and finally in May, 1920, the establishment of health benefits paid during illness and in proportion to length of service. Mr. Robertson emphasizes the belief of the Eastman Kodak Company in its medical service as a paying proposition and as a valuable asset in the development of "real red-blooded citizens." — Katherine R. Drinker.

MEDICAL SERVICE AS AFFECTING INDUSTRIAL RELATIONS. *Howell Cheney.* Nation's Health, Sept. 15, 1921, 3, No. 9, 512–514. — In this article Mr. Cheney discusses, from the point of view of the industrial physician, of the worker, and of the employer, the situation in which industrial medical service finds itself today, and the direction in which it is going. Guide posts along the road of progress are the insurance of a personal relation between the physician and the patient — a relation in which all communication from the patient to the physician is inviolate — and the preservation of friendly relations between the industrial physician and his fellow practitioners. The employer must keep it clearly in mind that society insists more and more that he can use his capital to make a profit only so long as he does not injure the community or his fellow-man.

The load which industrial medicine has to carry, according to Mr. Cheney, includes: "(1) examinations for employment; (2) the first aid treatment of all minor disabilities occurring within the plant; (3) the entire treatment of all industrial accidents; (4) a far more thorough examination and research into all of the production problems connected with health that are becoming more and more important to the industrial capacities of our plant; (5) life extension work . . . ; and (6) finally, the medical administration of mutual benefit or fraternal associations. They especially have been a constant force for education in helping to carry all of the various parts of the program."

Mr. Cheney next discusses the types of vehicle used to carry this load — first, the part-time physician whom he pronounces a failure; and second, the full-time physician, who, in order to be successful, must recognize clearly his relations to the industry and his relations to the employee, and must make no effort to treat bedside cases or cases of acute illness. Mr. Cheney says:

"We must offer every facility for diagnosis and for consultation but, except in the treatment of ambulatory cases, our whole effort must be to give the actual care of acute illness to the family physician. That is the only possible way in such cases. It is the only way in which all of the parts of the treatment of the case can be covered. No one in industry has yet any conception of the possibility of taking on the whole load of medical treatment. As I look on it, it is impossible from either a social or an economic point of view.

"There is a third vehicle — suggested by the valuable work that the Life Extension Institute has done — of an association of physicians offering their services to both employers and employees, combining in one co-operative association all the most highly developed diagnostic aids available, which probably would be beyond the reach of any single physician; often, by calling in a specialist in consultation for special cases, dividing the expense, which at present is a difficult matter to divide. But, on the whole, the part that can be charged to the employer is becoming plain. He must pay for the examinations for employment, for the cost of accidents, and for the most valuable work in research. He can afford to pay a large part of the burden of expense for capital equipment, but when it comes to the burden of individual treatment of sickness, that must be borne by the individual patient. But you industrial physicians can make it possible for the day laborer to have every diagnostic facility and to have within his call specialists for consultation. When you have done that, you will have solved the relationship with the individual, as you have already solved the relationship with the industry."

The article concludes with a brief discussion of the goal of industrial medicine. — Katherine R. Drinker.

THE INDUSTRIAL MEDICAL DEPARTMENT OF THE FUTURE. *A. E. Chace.* Jour. Ark. Med. Soc., Sept., 1921, 17, No. 4, 81–85. — The author believes that the work to be done by the medical department varies with the character of the industry and the management, but that in order to accomplish this work the four essential requirements are:

1. Adequate means of financing the work.
2. The best modern technic should be used in the work.
3. The records should be complete and "so summarized as to be profitable."
4. The department should be used "as a

teaching institution to give *esprit du corps* and incentive to the workers and to further the legitimate aims of industrial medicine and surgery."

Each of these suggestions is dealt with in full and the following summary is given:

"If all industry is organized in some such manner as I have outlined, what is to become of the physician in private practice? Last fall, at Montreal, Dr. Will Mayo said something to the effect that group medicine must come or the physician would lose his caste, if not his income. Is not this another way of saying that the physician must cease to be a social hermit and become a component part of our social structure? Social structure in the sense of co-operative effort for the community.

"Medical literature has been glutted with what surgeons have learned from the war, or how little we have learned. Of one thing there can be no doubt — we did learn co-operation. Industry learned the value of co-operative effort in medicine and surgery. We have already forgotten, many of us, this lesson. Industry never will. Industry requires money, and those who have the handling of it have learned that lesson for all time. The healthy community is the prosperous one. The healthy industrial personnel is the efficient one. Both of these ideals will be served by the correlated work of physicians and surgeons, who have forgotten the small things and grasped the big opportunity for service, taking with them those scientists whose labor is essential to the purpose." — M. C. Shorley.

A Room that Stops Sneezing. *Sanford De Hart.* Factory, Oct., 1921, 27, No. 4, 482–483. — There is more time lost in industry from the common cold than from any other one cause. Every plant has this problem to deal with and the R. K. Le Blond Machine Tool Company has solved it by installing in its hospital a nose and throat room which is used primarily for the treatment of colds, sore throats, stiff necks and kindred diseases.

"The equipment consists of a tankless compressed air apparatus with six atomizers and a high frequency apparatus with special surface and internal electrodes for all parts of the body. The atomizing apparatus and the high frequency apparatus, together with the compressed air pump, are combined in one cabinet and operated on a 110-volt direct current. The atomizer solutions are largely alkalines, and are used for spraying the nose and throat. The high frequency apparatus is applied to painful areas of rheumatic or neuralgic origin."

No man is treated who has any elevation of temperature as he is looked upon as a possible focus of infection to fellow employees, and he is advised to go home and see his doctor. "A man with a cold wants immediate relief or he goes home" which is just what the company does not want if he is well enough to work, and by urging every man with a cold to come to the nose and throat room this company was able to cut absenteeism, during the influenza epidemic, "down to 9 per cent. of our total working force, while some other plants had as high as 50 per cent. absent." — M. Dent.

Dental-Oculist Service for Workers. *L. E. Hastings.* Hosp. Management, Sept., 1921, 12, No. 3, 72, 74. — Dr. Hastings outlines the growth of the dispensary of the J. G. Brill Company of Philadelphia from its beginning, in 1913, as a first-aid room in charge of a part-time physician and a full-time assistant up to the present time when the personnel comprises a dentist, a physician, a graduate nurse, and a clerk. A report of the work of the dispensary during the past four and a half years is included which shows a notable reduction in the number of accidents and in time lost. — M. C. Shorley.

Personal Call on Employees. *W. T. Barbour.* Hosp. Management, Sept., 1921, 12, No. 3, 80. — The medical service of the Detroit Stove Works includes first aid and follow-up dressings for all accident cases, or hospital care, if necessary; temporary care for all cases of illness occurring in the factory, followed by care at home, to see if the patient is receiving proper medical attention. One of the important duties of the nurse who is in charge of the department is to call upon each employee in his home for the purpose of investigating his living conditions and his apparent circumstances. A copy of the blank used for recording this information is included. — M. C. Shorley.

## INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

Scientific Method in Job Analysis. *H. D. Kitson.* Reprinted from Jour. Pol. Econ., June, 1921, 29, No. 6, 508–514. — Usually job analysis is crudely done, and consists of a rough observation by the employment manager in consultation with the foreman, master mechanic or expert operator. The unit operations thus found are written up in the form called job specification.

Suggested improvements are two: that observations should be more accurate and minute; and that they should be repeated under controlled conditions giving quantitative results. Thus far only one-half of the problem has been attended to — the analysis of individuals to determine their qualifications in terms of general intelligence, special abilities, etc.

To illustrate the methods of scientific job analysis, a brief report is made of a study of some of the processes of proof reading. Tables show the amount of work done by eleven workers, and the frequency of errors; and a method used for studying eye movements is described, with some graphic records. From all this some of the qualities of a good proof reader as compared with a poor one are determined.

Such detailed analyses, the writer says, may be used by the employment manager to supplement the measurements made of applicants, furnishing an intelligible and concrete pattern into which the analyzed abilities of the applicant may be fitted; the educational director may use the results in training new workers; the production manager may use this method in discovering the wastes in operations and so devise more efficient methods of work; and, finally, the cost accountant, with the measurements of the factors of a job at hand, may make better estimates of the cost of new jobs about to be contracted for. — G. E. Partridge.

## INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

Twenty-Ninth Annual Report of the Maryland State Board of Labor and Statistics, 1920. Maryland State Board of Labor and Statistics, 1921, pp. 429. — This is a report of the enforcement of laws relating to child labor, hours of employment for women, and factory and mining inspection, and also contains information concerning industrial registration, employment service, strikes, agriculture, cost of living, census and a financial statement. — M. Dent.

Labour Legislation in France during and after the War. *R. Picard.* Internat. Labour Rev., July–Aug., 1921, 3, Nos. 1–2, 27–40. — This article reviews the legislation adopted in France during the war to provide exemptions from restrictions on hours of work, etc.; the later reaction toward protection and enforcement of regulations; the manner in which the unemployment problem was dealt with; prevention of too much influx of foreign labor; regulation of the work of women, and the efforts to reduce to a minimum the amount of women's employment in munition work; control of wages paid by the army contractors; and encouragement of consumers' co-operative societies. There is also a brief survey of the law in France instituting the eight-hour day and affecting the system of collective bargaining, of trade unionism, and of arbitration committees, and there is a comment on the present unfavorable lack of protection of the agricultural laborer in France, who is not included in the eight-hour day restriction. The most important feature of recent legislation, the writer concludes, is the attempt that is made to bring in the worker and employer to help in the work of legislation, "whether by consultation, or by entrusting them with the management of new institutions, or by increasing the power of their organizations and allowing them to formulate their own laws." — G. E. Partridge.

New York State Workmen's Compensation Law, with Amendments, Additions and Annotations to September 1, 1921. N. Y. State Dept. Labor, 1921, pp. 120. — This pamphlet contains the New York State Workmen's Compensation law amended to 1921, and includes coverage and definitions, compensation, occupational diseases, insurance methods

and regulations, powers and duties of commissioner and board, custody and management of state insurance fund, miscellaneous provisions, repealed laws, and also an "index and an alphabetical finding list of employments covered by the law." — M. Dent.

Flexion Power as an Index to Functional Efficiency in the Appraisement of Disability in the Upper Extremity, Resulting from Industrial Injuries. *Frank L. Barnes.* Texas State Jour. Med., Sept., 1921, 17, No. 5, 247–249. — The Workmen's Compensation Law, or Employers' Liability Act, of Texas, makes the general provision that "while the incapacity resulting from the injury is total the workman shall receive 60 per cent. of his average weekly wages, but not more than $15.00 per week nor less than $5.00, for a period not greater than 401 weeks from the date of injury. When the incapacity is partial or becomes partial, his weekly compensation shall be equal to 60 per cent. of the difference between his average weekly wage before injury, and his average weekly earning capacity during the existence of such partial incapacity, in no case to exceed $15.00 per week, and for no greater time than 300 weeks. The period of compensation for both total and partial disability not to exceed 410 weeks from the date of injury."

The loss of both hands at or above the wrists and a similar loss of one hand and one foot are, according to the law, total and permanent injuries. In the case of certain other injuries, which the author enumerates, specified compensation for fixed periods of time is provided. There are, however, no provisions made for "injuries which have reached a more or less final condition nor for those which have produced a greater or less residue of disability," and it is these conditions which the author discusses particularly. He outlines certain principles for estimating the degree of functional loss in all cases of disability and then gives special consideration to the upper extremity. "Practically all of the movements of the upper extremity are for the purpose of bringing the hand into position to function or to assist or to augment its power of function. The hand, then, is the essential part of the upper extremity and its chief function, including that of the fingers, is flexion."

From his experience in a great number of cases of fractures and dislocations in the upper extremity, the author estimates that at least 80 per cent. of the disability is found to be what may be termed flexor disability. In conclusion he states that "since, then, flexion is the chief function of the industrial worker's upper extremity and all other movements are subsidiary to it, I maintain that the amount of flexion that can be voluntarily exercised by an upper extremity in a regular, co-ordinated and correlated way, is the proper index of its efficiency, and that the amount of voluntary flexion power that is lost by reason of injury fairly represents its residue of disability." — M. C. Shorley.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

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CONTENTS



## GENERAL

THE INDUSTRIAL PHYSICIAN AND THE HOSPITAL. *Harry Linenthal.* Nation's Health, Oct. 15, 1921, 3, No. 10, 562-564.—In this article Dr. Linenthal discusses briefly the opportunities for co-operation between the industrial physician and the general hospital. The industrial physician when confronted with a case which is obscure and which his necessarily limited diagnostic facilities do not enable him to solve, can send his patient to the general hospital and so secure the services of its corps of experts and of its laboratory facilities. The general hospital will gain from such a relation because its physicians will be brought in contact with the wide field of industrial health relations and with the broad social aspects of medicine.

"To have such co-operation between industry and hospital most effective it is presupposed that the hospital has a special interest in conditions of employment and industrial hazards, in other words that the hospital has a special clinic with physicians in charge who are interested in health problems in industry and in the possible etiologic relations of various health hazards."

Such a clinic ought to be an agent for carrying on further research on the effects of industry upon health. "Our lack of knowledge of the general effects of industry on health is due to our inaccurate records and inexact tabulations. It is true we have a good deal of definite knowledge of the specific industrial diseases, the occupational intoxications and infections, we are also able to recognize the etiologic value of such industrial hazards as dust and fumes, postural strains, etc.

"But what the effects are of certain occupations on health, the frequency of morbid-

ity and mortality from certain common diseases among certain groups of operatives; the effects of the general stress of industry, the speeding up, the monotony, the general fatigue effects we know but very little.

"Such additional knowledge is," Dr. Linenthal believes, "to be obtained from the analysis of large numbers of records with a view of establishing a correlation between the occupations and the diseases.

"It is only the tabulation of vast numbers of cases that will permit deductions as to the relative frequency of certain diseases among certain groups of workers.

"That valuable information can be gained by such statistical studies and that facts of importance can be brought out which do not become obvious even in the careful handling and study of the individual case is illustrated in an analysis of even as small a number as 10,360 admissions of persons in industry to the Out-Patient Department of the Massachusetts General Hospital." To cite one instance:

"In the 10,360 cases tabulated the diagnosis of gastric ulcer was made 79 times; 26 of these, or more than 34 per cent. occurred among workers in candy factories. The diagnosis of gallstones was made 46 times, 26 of these, or more than 56 per cent. occurred among the same group of workers. Yet the entire number of candy workers was 205, or less than 2 per cent. of the number of admissions."

Dr. Linenthal concludes with an expression of his opinion that the industrial clinic "because of its special interest in research in industrial problems and because of its intimate contact with industrial physicians through cooperation along the lines indicated above can well serve as a center where the experiences of all physicians in industrial plants can be collected and progress made in our knowledge of the effects of industry on health."—Katherine R. Drinker.

The Practitioner and the Industrial Physician. *Charles Edward Mongan.* Nation's Health, Nov. 15, 1921, 3, No. 11, 609-612.—In 1912 the first workmen's compensation law was passed in Massachusetts, and by this law the individual was denied the right to select his own doctor. This caused considerable resentment and the law was later changed, restoring to the individual the right of free choice of his physician.

The entrance of the private practitioner into the field of industrial medicine has brought up the question of the proper fees to be paid to the practitioner by the insurer, both in hospitals and at the patient's home. There is a question also as to the extent that the industrial physician is justified in carrying on his work beyond the walls of the factory, thus encroaching upon the legitimate field of the practitioner. The author of this article, as a member of the Medical Advisory Committee of the Industrial Accident Board, discusses these questions with a view to promoting co-operation between the industrial physician, the private practitioner, and the insurer.—L. A. Shaw.

The Health of Seamen and How to Safeguard It. *E. J. Mackeown.* Jour. State Med., Oct., 1921, 29, No. 10, 289-296.—It is strongly urged that (1) there be created by representations to the Board of Trade, Ministry of Health, Admiralties and the Council of the League of Nations, an international standard of accommodation on board ships for seamen; and that (2) legislation be established providing that all plans of ships to be built must be submitted to a central authority in each nation. Plans must show the accommodation provided for the crew, and work on the ships is not to be proceeded with until the accommodation plans have been approved. Inspection must follow regularly during construction.—Barnett Cohen.

The Influence of Night Work on the Health of Workers. *Hermann Brückner.* Zentralbl. f. Gewerbehyg., Oct., 1921, 9, No. 10, 217-224.—Basing his conclusions on interviews with many workmen and on statistics covering a seven-month period in a large plant, the author decides that night work is the safest of the three shifts. It is complained of as unpleasant but not as a cause of disease. Difficulty in sleeping in the day time is a possible factor in the poor health of neurasthenics, justifying their exclusion from night work. Accidents and intoxications are less frequent at night, probably because the work is less intense and only the essential and mechanical processes are carried on then.—E. L. Sevringhaus.

# SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

## MENTAL

The Place of Occupational Therapy in Mental Hygiene. *Norman L. Burnette.* Pub. Health Jour., March, 1921, 12, No. 3, 103-106. —The author recapitulates the benefits to be derived from having the mind occupied, and claims that if more occupational therapy were taught to the maimed and sick in hospitals there would be a less steady tide flowing asylumward.—M. Dent.

# POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

Memorandum on Carbon Monoxide Poisoning in Factories. Form 827, July, 1921, Factory Department, Home Office, London, pp. 13.—Gases containing a considerable proportion of carbon monoxide are now used extensively in industries for such purposes as driving gas engines, heating furnaces, kilns, retorts, ovens and boilers, and welding and soldering metals. Similar gases are produced as by-products in various metallurgical and other processes. A list of the various types of these gases is given.

Air containing over 0.2 per cent. of carbon monoxide is dangerous to life, and smaller quantities inhaled over long periods produce ill-health, as the gas forms a definite compound with the hemoglobin. The Annual Report of the Chief Inspector of Factories shows that there is an increasing number of reported cases of industrial poisoning by carbon monoxide. These cases of poisoning are due to ignorance of the danger, to the inodorous nature of the gas in certain forms, to working alone, and to lack of rescue appliances or failure to maintain them properly.

The principal causes of accidents are these:

"*Producer gas.*—(1) Charging, stoking, cleaning, and repairing the generating plant; (2) starting the engine; (3) escape from the vent or exhaust pipe of the engine directly into the workroom, or indirectly into the workrooms through open windows in the case of pipes discharging outside; (4) leaky fittings and pipes; (5) defective valves, water seals, etc.; (6) conveyance by the wind; (7) persons lying down or sleeping near a gas engine or plant; (8) percolation through the soil or brickwork from underground pipes.

"*Blast furnace gas.*—From (1) charging; (2) gauging the furnace; (3) repairing furnaces, flues, etc.; (4) cleaning flues or culverts without efficient disconnection; (5) unsuspected escape from underground flues into weigh cabins, offices, etc.; (6) carriage of gas by the wind from one furnace to the gantry staging of another or elsewhere.

"*Gases from other sources.*—From (1) open braziers or coke stoves used for drying purposes in confined spaces on ships, in garages and elsewhere; (2) coke ovens; (3) lime and cement kilns; (4) bakers' ovens through broken tiles; (5) coke fire of galvanizing and other plants; (6) fires for heating rivets; (7) subterranean fires; and (8) exhaust gases from the testing and running of internal combustion engines.

"*Coal gas.*—(*a*) In gas works from (1) cleaning ascension and other pipes; (2) repairing cracks in retorts; (3) drawing gas retorts; (4) attending to purifiers; (5) leaky water seals and valves; (6) drilling mains and branch pipes; (7) repairing gas holders; and (*b*) in distribution in workrooms from (1) defective pipe joints, taps, and other fittings; (2) faulty gas irons or gas blowpipes; (3) inadequately ventilated gas stoves or heaters; (4) back lighting or ineffective draught at muffle and other furnaces, drying ovens, etc."

Preventive measures are suggested for the hazard of carbon monoxide poisoning in its general aspects and for each of the classes above mentioned. The general precautions include such as these:

Occupiers of factories, managers, and others concerned should take all possible steps to ensure that workers are aware of the danger from, and the symptoms of, carbon monoxide poisoning wherever gases of which this is a constituent are produced or used.

Persons should not be permitted to enter any place where carbon monoxide gas is liable

to accumulate until such place has been well flushed out by fresh air.

In the case of producer gas emphasis is laid upon the facts that cleaning and repairing on the producer should be done by daylight, and no fire, naked light, or smoking should be allowed near the plant. After the generator fire is out air must be blown through by the fan and the generator doors opened; and the plant should be left for several hours before any cleaning is done.

A large number of cases of poisoning occur in connection with the cleaning and repairing of flues, culverts, furnaces, stoves, etc., many of which could be avoided if more care were taken to see that the parts to be cleaned or repaired were properly cut off from any supply of gas, the parts thoroughly flushed out, plenty of time allowed for cooling and for ventilation, and to see that every workman wore a lifebelt to which a line is attached, held continually by some person outside the furnace, flue, etc.

Open braziers or coke stoves are frequently used for drying purposes in confined spaces, and persons entering such places before they are thoroughly flushed may be overcome. In the case of coke ovens, lime and cement kilns, danger usually arises from men entering the ovens, kilns, or flues before adequate measures have been taken to remove the gas by proper ventilation.

The most serious cases of gassing from coal gas usually occur in connection with cleaning and repairing plants in gas works. Special precautions should be taken to cut off all gas supply, to flush out residual gas, and when there is danger apparatus should be worn enabling the workman to obtain a supply of fresh air from outside, and a life-belt should be worn. The rescue apparatus most suitable for industrial work consists of a facepiece connected by equalizing tubing with a flexible hose pipe 50 feet long, the free end remaining in an outside atmosphere. This apparatus is preferred to the complicated, self-contained breathing apparatus required in mines.

Symptoms of carbon monoxide poisoning are: giddiness, swimming sensations, constriction in the head and oppression on the chest, throbbing of the heart and larger blood vessels, loss of power in the legs, followed by complete helplessness and unconsciousness. The after-effects are: headache, bronchial symptoms, depression, prostration, loss of vitality, and tachycardia. Sequelae such as paralysis, paraplegia, hemiplegia, and loss of memory with affection of speech, occur.

A method of examination of the blood for carbon monoxide poisoning is given—the comparison of the tint of a greatly diluted solution of the suspected sample with that of normal blood. The latter is yellow, while blood containing even very small traces of carbon monoxide is pink.

Respirators of the ordinary type are useless against the inhalation of carbon monoxide, and reliance on a folded handkerchief has cost many a rescuer his life. Workers are especially warned against adopting the method employed by ignorant persons of placing men on their faces with the mouth over a hole in the ground. The combination of artificial respiration with oxygen administration is decidedly preferable to the use of apparatus for inflating and deflating the lungs with compressed oxygen. Warmth is essential in the treatment; the patient should be wrapped in dry blankets and hot-water bottles applied. The restoration of breathing is the first and immediate object, and then promotion of warmth and circulation. The efforts to resuscitate a victim should be continued for a long time, since life may be saved in cases that seem hopeless. Phenacetin, aspirin, etc., should never be given to relieve the headache from inhaling carbon monoxide gas.

Reference is made to a new gas mask to be used as a protection against carbon monoxide, which is described in a paper on *Industrial Respirators*, by Levy and West, read before the Society of Chemical Industry, June, 1921 (to be reviewed in the next issue of the JOURNAL).—G. E. Partridge.

MEMORANDUM ON INDUSTRIAL LEAD POISONING. Form 324, Jan., 1921, Factory Department, Home Office, London, pp. 16.—Valuable information is to be obtained as a result of the statutory requirement that the Chief Inspector of Factories must be notified of cases of lead poisoning in Great Britain and Ireland.

Industrial plumbism is practically always a result of inhalation and absorption, from the alimentary or pulmonary tract, of dust and fumes. Figures for the pottery industry seem to show that women are about twice as susceptible as men, but this may be due to the

relatively greater dangers from the processes, or to the average shorter term of employment. Two-fifths of all reported cases occur during the first eighteen months.

A table shows the number of cases of plumbism and the number of deaths occurring in various industries during the past twenty years, the average being given for each half-decade. The totals of cases for the four half-decades are: 1900-1904, 753; 1905-1909, 599; 1910-1914, 548; 1915-1919, 279. The statistics show also a reduction in the severity of the attacks and a decreasing proportion of recurrent attacks (for the three periods from 1900 to 1915).

The figures are recorded also in regard to the frequency of different symptoms for the three periods, and of the different forms of paralysis and encephalopathy. The numbers employed in the main industries in which lead poisoning occurs, and the attack rate per thousand for these industries are given.

Some attempt is made to analyze the industries and to show the processes in which the hazards occur, also to indicate the sources of improvements that have been made. The electric accumulator industry is shown to be the one now exposing workers to the greatest risk. A section is devoted to symptoms and diagnosis, with special reference to anemia, colic, arthralgia, effects upon the nervous system, paralysis, interstitial nephritis, and gout.

Special attention should be given to new workers, as the appearance of symptoms of poisoning in them constitutes the surest guide to defects in the processes. The most delicate test for the detection of early extensor paralysis is to have the surgeon place the tip of his forefinger on the outstretched hand of the worker and the ball of his thumb on the extreme tip of each finger, then gently pull it down and note the spring present in the muscles.

Approximately 2 mg. is the lowest daily dose which, inhaled as fume or dust, may, in the course of years set up chronic plumbism. Probably if the air breathed contained less than 5 mg. per 10 cubic metres of air, cases of encephalopathy would never occur, and cases of colic would occur very rarely. And this is a quite practical figure to keep the dust down to in any process amenable to exhaust ventilation.

As to notification, suspension and warning, necessity for notification arises only when lead poisoning is diagnosed, and in general only when the symptoms are of such a nature as to require absence from work. Liability to injurious effects may be indicated by present or past attacks of lead poisoning, by tendency to epilepsy or hysteria, by marked anemia, extensive oral sepsis, mental weakness, and careless habits. Persons who have suffered from malaria or any condition which has brought about blood destruction, and ex-soldiers who have been gassed should not be subjected to the risks under discussion. Where the diagnosis of acute plumbism is clearly established, suspension from employment should be ordered.

Codes of regulations for medical examination and inspection in various industries are given, and also directions in regard to the keeping of health registers.—G. E. Partridge.

The Clinical and Pathological Manifestations of Lead Poisoning. *P. Pincherle.* Il Lavoro, Oct. 31, 1921, 12, No. 6, 161-168.—The author examined the urea content of blood in urine in twenty patients suffering from lead poisoning and made use of the sodium hypobromite method. Sixteen of the twenty cases showed a concentration of urine in the blood above the normal, the quantity running from 0.45 gm. to 3.7 gm. per thousand. The lesions found at three autopsies were typical of the contracted kidney of chronic saturnism.—Alice Hamilton.

Comparison of Mumps and Chronic Lead Poisoning from the Standpoint of the Totality of Symptoms. *Conrad Wesselhoeft.* Abstracted as follows from Jour. Am. Inst. Homeopathy, 1921, Vol. 14, pp. 13-29, in Chem. Abstr., Sept. 10, 1921, 15, No. 17, 2922. —"The symptoms of chronic lead poisoning and those of mumps resemble each other in many respects. The most striking similarity is the parotitis, commonly complicated by orchitis which is often followed by testicular atrophy. A bibliography of 67 references is appended."

Prohibition of the Use of White Lead in Painting. Official Bulletin, International Labour Office, June 22, 1921, 3, No. 24, 686-690. —This paper reports the views of the White Lead Corroders' Trade Section of the London

Chamber of Commerce on the subject of prohibition of white lead in painting. It is argued that:

1. Because of the complexity of the subject, difference of views, etc., this question should be submitted to the Advisory Committee which the Washington Conference resolved should be established to deal with such questions in industrial hygiene.

2. The statistics of lead poisoning do not warrant prohibition. Many cases are wrongly diagnosed. Tests made at the Leipzig Institute of Hygiene by the objective basophilic granulation method confirmed only 38 per cent. of the cases ascribed to lead poisoning by subjective clinical diagnosis. "There is reason to believe that the risk of paint poisoning among painters in England is not more than an ordinary industrial risk."

3. There is no effective all-round substitute for white lead in painting.

4. The prohibition of white lead would not remove all the chief causes of painter's sickness. Turpentine, benzol, methyl alcohol, etc., have poisonous properties which are believed to be the cause of the frequency of kidney diseases and gout among painters, but workers in white lead factories do not commonly suffer from these diseases. The dangers from lead are, moreover, readily avoided by simple regulations, by substitution of wet processes in rubbing, etc., by general cleanliness and avoidance of such obvious risks as those from paint-soiled hands.

5. Prohibition would be very costly, would be difficult to enforce and of doubtful effect.

6. Regulations alone would effectively deal with the cause of paint poisoning among painters.—G. E. Partridge.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

A Memorandum on the Occupational Study of Syphilis, with Special Reference to Farmers. *John H. Stokes* and *Helen E. Brehmer.* Am. Jour. Med. Sc., Oct., 1921, 162, No. 4, 572-575.—The authors made an investigation of syphilis in 100 railway men in January, 1919, and later a survey of 100 farmers was undertaken in order to "determine whether occupation as such could serve as a factor of predisposing or modifying influence in the course of the disease." The conclusions reached are as follows:

"1. A survey of syphilis in 100 farmers whose records were taken at random from the files of the section of dermatology and syphilology in the Clinic (Mayo Clinic) reveals no distinctive difference between the clinical picture of the disease in farmers and that in railroad men.

"2. This result is not to be interpreted as precluding the possibility of special occupational types in the disease. For the determination of such types the investigation must be taken to the groups instead of subjecting the group to a species of unconscious medical selection involved in resort to a diagnostic clinic.

"3. The figures given in the table, therefore, present essentially the diagnostic problem of late syphilis in general medicine. They suggest further that physicians at large could profitably give less attention to the history of infection and the serum Wassermann test and more attention to the spinal fluid test and to the physical and especially the neurological and ophthalmic findings in their effort to recognize late syphilis and to interpret the medical picture presented by a given patient."—C. K. Drinker.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

How We Die from Accidents in Careless America. *Frederick S. Crum.* Nat. Safety News, Oct., 1921, 4, No. 4, 17-18.—An effort was made by the National Safety Council to determine the approximate number and causes of fatalities in the United States during one week. During the week which ended August 28, 1,208 deaths by accident occurred; of these "no fewer than 758, or 67.7 per cent., were the result of *public* accidents; 359, or 29.7 per cent., were the result of *industrial* accidents; and the remainder, 91, or 7.5 per

cent., were the result of *home* accidents."—M. Dent.

Hours before Noon and Quitting Time Most Prolific of Accidents. *Howard Van Antwerp, Jr.* Nat. Safety News, Nov., 1921, 4, No. 5, 30.—With the Ashland Iron and Mining Company the peak hours for accidents are from 10 to 11 A. M., and 3 to 4 P. M., these being the hours when production is most speeded up at this plant, and when hunger and fatigue play a very important part in carelessness. The company's emergency hospital has more than paid for itself in the reduction of time of recovery, and a campaign against eye injuries resulted in a reduction of from $3,000 paid out during one year for this class of accident to $65 for the eight months following the campaign.—M. Dent.

Campaign against "Dropsy," the Careless Handling of Materials. *Fred M. Rosseland.* Nat. Safety News, Oct., 1921, 4, No. 4, 15-16.—The handling of materials in industry is a very serious cause of accidents. Men are naturally careless in handling materials unless the slogan of care is repeated very often. Another source of danger is carelessly piled material. During the past ten years many successful inventions for the handling of materials have been placed upon the market, and the use of these, together with safety propaganda, should be insisted on by all plant managers.—M. Dent.

Trends in Management. The Direction Industrial Fire Prevention Is Taking. *W. E. Mallalieu.* Factory, Oct., 1921, 27, No. 4, 478-480.—We should learn a great deal from the very efficient fire prevention work done during the war for the protection of wooden cantonments, naval properties, food storage and munition factories. The *per capita* fire loss in wooden cantonments averaged approximately one-fifth that of civilian cities.

Industrial fire inspection can see to it that the building is rendered safe as far as is possible by fire escapes, and can oversee the employees and do away with careless habits which may cause fire. The article gives details on watchmen, sprinklers, fire drills, and an orderly factory.—M. Dent.

"Give Me Another Pair of Goggles—Just Broke Mine." *Fred M. Rosseland.* Nat. Safety News, Nov., 1921, 4, No. 5, 31-32.—Goggles should only be required when no other form of protection is adequate. Glass screens on emery wheels and screens between workers and machines from which flying particles proceed are better than goggles.

The quoted procedure should be followed in undertaking an eye protection campaign in any plant:

"1. Check up the various jobs and find just where safety goggles are necessary—where no other protection will be adequate.

"2. Check up the goggles worn by each employee and determine whether they fit properly and whether they give adequate protection.

"3. As fast as possible locate employees who are encountering difficulties in wearing goggles, and investigate each case . . . Here attention should be given to the subject of vision.

"4. At the same time a course of education in eye protection should be carried on."—M. Dent.

The Sources of Danger from Accidents in Building Industries. *R. Quarg.* Zentralbl. f. Gewerbehyg., Oct., 1921, 9, No. 10, 229-232.—Statistical study of the accidents in the building industries of Thuringia during 1920, with an attempt to fix the responsibility for accidents when possible, leads to the certain conclusion that a large percentage is due to the carelessness of workers and employers, and to failure to observe the rules. Industrial supervision must include not only formulating rules and introducing devices, but also the education of the workers in safe practices.—E. L. Sevringhaus.

A Peek behind the Scenes at Railroad Safety. *Louis Resnick.* Nat. Safety News, Oct., 1921, 4, No. 4, 9-12.—This article describes the nervous strain that is put upon the engineer of an express train while making runs, and shows how thoughtless people are in matters of safety when they calmly walk on the tracks until the train is almost on top of them, or speed up their motors in order to beat the train to a crossing—for all of which the engineer pays in fearful mental anxiety.

The safety work of the Baltimore and Ohio Railroad is described. It consists in ceaseless

inspection and ceaseless vigilance. No locomotive is used more than five hours during a trip, and each locomotive is inspected by a gang of men before each trip. The company has no difficulty in educating its employees but has great difficulty in educating the public.—M. Dent.

Safety in Steel Making. *R. C. Salisbury.* Nat. Safety News, Nov., 1921, 4, No. 5, 32.—This article outlines briefly the safety features installed in the new merchant mill of the Interstate Iron and Steel Company at Chicago, and the safety policy of the company.—M. Dent.

Accident Frequency Rates in the Iron and Steel Industry, by Causes, 1913 to 1920. *Lucian W. Chaney.* U. S. Bur. Labor Statis., Month. Labor Rev., Sept., 1921, 13, No. 3, 487-492.—"For some years past the Bureau of Labor Statistics has been able to secure for the iron and steel industry a very considerable body of accident data classified by accident causes. These data brought down to the end of 1920 are presented herewith."

"Table 1 shows the variations in the frequency rates for accidents from the several causes from year to year, 1913 to 1920.

"Table 2 presents the frequency rates for the whole period arranged according to production groups.

"Table 3 shows the variations in the rates for the several production groups, by years, during the 8-year period."—R. B. Crain.

Accident Frequency and Severity Rates for the Iron and Steel Industry and its Principal Departments, 1907 to 1920. *Lucian W. Chaney.* U. S. Bur. Labor Statis., Month. Labor Rev., Oct., 1921, 13, No. 4, 886.—"It should . . . be noted that the figures in this presentation are restricted to accidents for which severity as well as frequency rates could be computed. They are not, therefore, comparable in any case with the figures shown in the article on 'Accident frequency rates in the iron and steel industry, by causes, 1913 to 1920,' in the September, 1921, issue of the *Monthly Labor Review* (pp. 1 to 6), which covered a much larger number of accidents, for which frequency rates could be shown, but for which severity rates could not in all cases be computed."

Steam Boilers or Steam Pressure Apparatus? *Schlippe.* Zentralbl. f. Gewerbehyg., Oct., 1921, 9, No. 10, 238-244.—The legal regulations concerning steam boilers, piping and steam driven machinery are discussed, with special attention to borderline cases between the different classifications, such as the fireless steam locomotives.—E. L. Sevringhaus.

Steam Boiler Safety and Operation. *J. A. Snyder.* Nat. Safety News, Oct., 1921, 4, No. 4, 19-20, 31.—This article, after an introduction concerning the number of steam boiler explosions in the past forty years, outlines briefly the rules and regulations of the American Society of Mechanical Engineers for the safe design and construction of steam boilers, taking up factors of safety, safety valves, steam gages, water columns, blow-off valves and pipes, accessories, valves, repairs, common defects, and low pressure boilers.—M. Dent.

## INDUSTRIAL SURGERY

Standardized First Aid in Industrial Plants. *R. A. Brintnall.* Nation's Health, Oct. 15, 1921, 3, No. 10, 543-547.—"Since the winter of 1912-1913, the Bell Telephone Company of Pennsylvania has been training its men in first aid work and life saving. The training has been given to the employees by forming units in each town and in each line of telephone work so that there are available at all times one or two men in each department able to render first aid to the injured. In this manner much has been accomplished in the way of concrete results, one significant indication being the reduction in the number of lost-time accidents as shown by the following comparisons:

"Lost time per every 100 employees was—in 1916, 10.47; in 1917, 7.62; in 1918, 5.66; in 1919, 3.98; in 1920, 2.69,—which means that they have succeeded in reducing the lost-time accidents in 1920, 7.78 as compared with 1916.

"As the training of these groups had been carried on for a number of years, it was conceived that active competitive effort between groups would help to maintain a continued

and well-sustained safety activity. To this end there were organized safety meets in which the groups of the different divisions competed with each other for a record. These have been carried on by the Bell Telephone Company since 1916."

Mr. Brintnall's article concludes with an interesting description of a first-aid contest held early in 1921 under the auspices of the Philadelphia Division of the Bell Telephone Company and the American Red Cross and in which eleven company teams competed.—Katherine R. Drinker.

The Transportation of the Injured. *R. R. Sayers.* Nation's Health, Oct. 15, 1921, 3, No. 10, 569-572.—Dr. Sayers' article deals with the transportation of the injured in metal mines and coal mines, and contains illustrations and descriptions of different types of transporting apparatus. The paper concludes with the following summary:

"The reasons for transportation are to get the injured man to a place of greater safety, to make him more comfortable, to prevent further injury through handling, and finally to get him where he may receive proper treatment.

"How to transport, or the method of transportation, may be one-man, two-man, stretcher squad, or car transportation—any one or all of which may be used for one or more injured persons.

"When to transport an injured person will depend upon the nature of the injury—for he often must receive proper first-aid or emergency treatment prior to transportation—whether the present location of the patient is safe or not, and the availability of assistance for transportation, and the availability of capable and efficient equipment and personnel for treatment."—Katherine R. Drinker.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Rôle of Diet in Etiology and Treatment of Migraine and Other Types of Headache. *Thomas R. Brown.* Jour. Am. Med. Assn., Oct. 29, 1921, 77, No. 18, 1396-1399.—"I have attempted to sketch very briefly in this article the arguments in favor of the rôle played by diet in the production of migraine and other forms of headache, offering, it is true, arguments based mainly on clinical data, although supported in certain cases by laboratory findings. I feel from the study of my cases that in certain cases of migraine and other forms of headache, whatever the primary cause, diet plays some part in producing the symptoms of which the patient complains, and that by modifying the diet cure may be obtained in a few cases, and a very considerable amelioration of symptoms in many cases. In my series of fifty or more cases, carbohydrates seemed to have played the predominant rôle in the largest number of cases; animal-protein food in almost as many; special foods, notably sugar or eggs, in a very few cases, while in an occasional case the headache might be regarded as a definite expression of intestinal toxemia or bacteremia or of an error in purin metabolism. That some disturbance in liver function plays a part in these headaches is suggested by the fact that there is in some cases a temporary enlargement of the liver during and after the acute symptoms. While it is not always possible to determine to which special form of dietetic error the individual headache may be ascribed, nevertheless in many cases a very careful clinical analysis, supported by certain laboratory tests, offers us a clue as to the materia peccans, carbohydrate, animal-protein, or purin-rich food as the case may be. In cases in which it is absolutely impossible from the clinical evidence to incriminate any special food or foods, it is wise to place the patient first on a carbohydrate-free diet for a considerable period of time, and if this proves unsuccessful, then on an animal-protein-free diet. In certain cases such treatment will bring about a very marked improvement in symptoms, in a very few apparent clinical cure, although, of course, in a large number of cases no effect whatsoever. Finally, in this group of cases the treatment of which is peculiarly unsatisfactory, by many regarded as almost hopeless, this point of view is not justifiable, unless one realizes that in certain of these cases diet unquestionably plays a rôle, and that a proper recognition of this fact should manifest itself in the appropriate dietetic therapy."—C. K. Drinker.

Respiratory Efficiency in Relation to Health and Disease. *Martin Flack.* Lancet, Sept. 17, 1921, 2, No. 12, 593-599.—This paper was read as one of the Milroy lectures which were founded with a view to furthering knowledge concerning industrial diseases. The author shows by the results of experiments in the Medical Service of the Royal Air Force that "physical inefficiency is frequently associated with a state of respiratory insufficiency." Statistics of the medical examination of drafted men are cited, such as that "out of every 9 men called up 3 were placed in Grade 1, 2 in Grade 2, 3 in Grade 3, and 1 in Grade 4," and the army type of grading measures far below Keith's standard of grading.

This low physical status of drafted men was due to: (1) poor physique and presence of physical defects; (2) tuberculosis; and (3) diseases and degeneration of the heart and blood vessels. "Apart from these, however, a very important cause of defects of physique and of degeneration was the effect of occupation on workers."

Of the causes of the diseases and degeneration of the heart rheumatic inflammation of the heart was the greatest. "On the other hand, one of the most important forms of circulatory troubles was veneris varix in some form. The amount of this was surprising . . . especially in industrial districts and among older men. Varicosity of the veins of the lower extremities to an extent sufficient to disable or be dangerous was found to be very common. It may be pointed out that such diseases are largely associated with deficiency of the respiratory mechanism."

The author goes on to state that physical inefficiency is largely preventable with better sanitation and diet; and then proceeds to review our present knowledge concerning the respiratory function. He then takes up in great detail correct expiration, thoracic anatomy (extensibility of the lung), movements of the ribs, mechanism of circulation and compensatory mechanism.—M. Dent.

Respiratory Efficiency in Relation to Health and Disease. *Martin Flack.* Lancet, Sept. 24, 1921, 2, No. 13, 637-641.—This lecture, the second of the Milroy lectures on respiratory efficiency, deals with the nature and value of the tests employed with the flying force, special routine tests, the determination of vital capacity, and the diminution of vital capacity during disease. "Further observations quickly confirmed the view that in officers suffering from strain the diminution of the vital capacity was due to their inability to expire sufficiently to empty the lungs to their full capacity."—M. Dent.

Respiratory Efficiency in Relation to Health and Disease. *Martin Flack.* Lancet, Oct. 8, 1921, 2, No. 15, 741-744.—For bodily efficiency efficient respiration is necessary. After a period of bodily activity in infancy and childhood most people of the present day settle down to a sedentary life. "By virtue of lack of exercise, trade occupations, mode of clothing, etc., the inspiration of many people of the present day is defective," and there is a marked deterioration between the ages of 18 and 23.

But the effects of indiscriminate physical training are bad. The author believes that one of the most urgent needs of the times is a set of simple exercises for sedentary workers. These he has worked out and presents in full in this article. They take about ten minutes daily to perform and incorporate natural movements of the body. These exercises will preserve the physical efficiency of sedentary workers and will enable them to take occasional strenuous outdoor exercise without undue fatigue. They are "in no way designed to supplant recreational exercise nor to replace more elaborate systems of physical training."—M. Dent.

## HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

The Lethal Power of Electricity. *M. D'Halluin.* Abstracted as follows from Jour. de radiol. et d'electrol., 1920, Vol. 4, 254, in Physiol. Abstr., Oct.-Nov., 1921, 6, Nos. 7 and 8, 455.—"Death from electricity may be of respiratory or cardiac origin. The serious nature of the latter, though often ignored, is due to persistent fibrillation, which must be distinguished from 'folie ondulatoire,' from which recovery occurs. Low-tension currents

specially affect the heart. High-tension currents (1,200 volts upwards) inhibit the medulla and kill by asphyxia. Currents of 240 to 600 voltage produce both effects. Low-tension currents are not therefore harmless, but are most dangerous. Respiratory failure must be treated by accepted methods, but cardiac failure (diagnostic points are given) can only be restored by direct massage and oxygenation of the blood; intravenous injection of KCl (5 per cent.) helps. In dogs massage alone revived 37 per cent.; massage plus KCl 65 per cent. The toxicity of KCl depends rather on injection rate than on dose. In dogs the lethal dose is 14 cgm. per kilo if injected 20 mgm. per minute, but is 42 cgm. at the rate of 4 mgm. per minute per kilo of body-weight."—McKeen Cattell.

The Pathology of Electric Current Burns. *Stefan Jellinek.* Wien. klin. Wchnschr., May 29, 1921, 34, No. 20, 239-240.—Electric current injury of the skin is not simply a "burn," but a definite and specific histological picture different from anything else. The basal cells of the rete malpighii are lengthened 3 to 6 times into bundles paralleling the direction of the current. Such effects must therefore be considered in a new light. —Barnett Cohen.

## HEAT, COLD AND HUMIDITY

Experimental Researches on "Autocolloïdoclasie" from Chilling. *F. Widal, P. Abrami,* and *E. Brissaud.* Abstracted as follows from Compt. rend., 1921, Vol. 173, 207-212, in Physiol. Abstr., Oct.-Nov., 1921, 6, Nos. 7 and 8, 455.—"Dogs were exposed to cold by immersion in water at 2° to 5° C. for varying periods. According to the length of time of immersion they suffered from manifestations of shock in varying degree. Short periods produced only a 'crise hémoclasique' consisting of (1) leucopenia, white cells diminishing in 45 minutes from 12,000 to 5,000; (2) increase of lymphocytes and decrease of polymorph cells; (3) large decrease in clotting-time of the blood; and (4) diminution of the refractive index of serum. Further symptoms were pyrexia, dyspnea, nausea, edema, urticaria, and finally hemoglobinuria. These symptoms are identical with those following intravenous injection of foreign protein in the dog, and with those of anaphylactic shock in the dog. These forms of shock are therefore all three identical; the authors give the name 'colloïdoclasie' to the process involved."—McKeen Cattell.

## WOMEN AND CHILDREN IN INDUSTRY

Working Conditions of Women Wage-Earners in Georgia. U. S. Bur. Labor Statis., Month. Labor Rev., Oct., 1921, 13, No. 4, 877-881.—This is a survey of the working conditions of women in Atlanta, Georgia. The industrial opportunities seem less varied in Georgia than in other southern states. The survey takes up the number of colored as against white women employed (the colored women generally in more menial positions), hours of labor, earnings (ranging from under $2 to over $20), and working conditions which vary greatly with different establishments. A serious feature "was the frequency of unnecessary hazard, such as unguarded machinery, uninclosed elevator shafts, and the like, 53 plants being found to present such dangers. Drinking facilities were often insufficient or lacking, as were facilities for cleanliness. Rest rooms, lunch rooms, first-aid equipment, and hospital rooms were rare."—M. Dent.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Illumination as a Factor Favoring Production. *R. E. Harrington.* Nation's Health, Oct. 15, 1921, 3, No. 10, 547-550.—In this article Mr. Harrington emphasizes the fact that although correct and adequate artificial illumination is a form of expenditure which brings the greatest return for the money invested, nevertheless many plant managers have neglected this opportunity to increase the overall efficiency of their plants.

"With a properly designed and installed lighting system there will result, as contrasted with the conditions under a poor system, better health conditions, less labor turnover, greater activities, better workmanship, fewer accidents and decreased spoilage. All of these factors combined assist toward the desired end —increased production."

Under the heading *Health of the Worker* Mr. Harrington discusses the reduction of eyestrain and the consequent reduction of fatigue and the increase of bodily efficiency, which adequate and properly planned illumination brings about. "Bad lighting will react to produce nervous, irritable, discontented employees;" good lighting, on the other hand, is "reflected in the faces of the operators, in the form of healthful, buoyant spirits."

Good lighting leads to material improvement in the general appearance of a plant. There are no longer dark corners to collect dirt and refuse. Clean, well-lighted workrooms are a factor in attracting workers and tend to reduce discontent and the amount of labor turnover. With adequate illumination accidents are reduced and there is less spoiled work because workers can see moving parts more distinctly and can gage their work more accurately.

Mr. Harrington next gives figures to prove that the points that he brings out are not theoretical, but that the cost of installing and operating a good system of lighting is more than compensated for in actual money by the saving of the employees' time.

"In order for the plant manager to determine the lighting intensities throughout his plant, it is desirable to have available an instrument, by means of which this may be done easily and quickly The foot-candle meter is an instrument self-contained and portable which meets these requirements. By means of this instrument a check may be kept on the lighting conditions in the plant. The manager or superintendent may easily determine whether or not the illumination for any given operation is comparable with what is considered sufficient for that operation."—Katherine R. Drinker.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Liable for Examination. *Eric G. Underwood.* Hosp. Management, Oct., 1921, 12, No. 4, 62.—This is a brief description of the medical department of Thomas de la Rue and Company of London. All employees of the company accept employment on the understanding that they are liable to medical examination, although actual medical examination is not made in every case at the time of employment. The medical advisor satisfies himself, however, that new employees are not suffering from any serious illness or disease which might affect the general well-being of the community. The present uncertain condition of the labor market is given as the reason for not insisting upon medical examination.

In each department of the factory there is employed a member of the voluntary ambulance brigade for treating accidents, illness, etc., and in each room there is a supply of first-aid materials. All injuries, no matter how slight, are reported to the medical department in order that a complete record may be on file in case of necessity.—M. C. Shorley.

Plant Hospital Faults. Hosp. Management, Oct., 1921, 12, No. 4, 64, 66.—Before establishing an employees' health service, the Champion Coated Paper Company of Hamilton, Ohio, had its medical director inspect a number of industrial hospital departments. Among the faults most commonly noted were (1) the absence of a systematic method of handling sickness, (2) the failure to arrange quarters and equipment properly, and (3) the lack of co-operation between the welfare department or industrial relations department and the health department—faults which this company aimed to avoid.

Under the present arrangement each applicant for work in the Champion Coated Paper Company is given a physical examination and is then classified according to the following groups: those without any physical defect; those having some minor imperfections; those having graver ailments which are curable; and those having some disease or impediment which makes them unfit for employment. At first, objections to medical treatment and examination were made by some old employees,

but this viewpoint has gradually been changed by the presentation of logical reasons. Lectures and advisory talks are given which help the employees to keep themselves fit.

A report of the work of the health service for the first year is given, together with comparative figures for the first month of the second year which show a definite reduction in time lost through accidents and illness.—M. C. Shorley.

## INDUSTRIAL NURSING

Nurses in the Guise of Industrial Physicians. *William Alfred Sawyer.* Nation's Health, Oct. 15, 1921, 3, No. 10, 566-568.—In this article, Dr. Sawyer discusses the extent to which nurses should be permitted to relieve industrial physicians of routine duties—a discussion which makes it quite clear that the nurse's whole authority should be the physician's orders, and that nursing care is not medical service. Dr. Sawyer goes on to say that if the industrial physician contents himself with routine giving of pills and bandaging of injured parts, or if he interests himself only in activities in which a nurse can be considered as able to supplant him, he cannot expect industrial medicine to offer him any real future. "The science of industrial medicine is yet to evolve, but it is in process," and the future is to the honest, far-seeing "worker who neglects none of his tasks and delegates none of his responsibilities."—Katherine R. Drinker.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

A Study of Industrial Absenteeism. *Robert S. Quinby.* Nation's Health, Oct. 15, 1921, 3, No. 10, 572-576.—This paper contains a very interesting account of the results of an investigation, covering a period of twenty-eight months, into the cause of absence among 6,700 factory employees of the Hood Rubber Company. The group studied was made up of 65 per cent. males and 35 per cent. females, of whom 55 per cent. were married, and 45 per cent. single.

The employees included in the investigation are classified by nationality, by age, according to the location of residence, and according to the length of employment. Next follows an account of the benefit plan which necessitated this detailed and accurate investigation into absenteeism. Finally, the following outstanding features in regard to the absence experience of the Hood Rubber Company during these twenty-eight months are given:

"The employees in the group covered by this investigation lost an aggregate of 215,442 days from work during the twenty-eight months of study. When reduced to days-lost-per-employee-per-year this represents lost time as follows:" sickness, 6.61 days per employee; industrial accidents, 0.45; non-industrial accidents, 0.25; personal reasons, 10.95; total for all causes, 18.26.

"The total average lost time from all causes during this period has been 5½ per cent. of the working time, of which approximately 2 per cent. was lost time on account of sickness, 0.14 per cent. on account of industrial accidents, and 0.08 per cent. because of non-industrial accidents. A study of our experience would indicate that, except in very unusual periods, sickness disabilities should not exceed 2 per cent. of the working time, or, in other words, six days per employee, based on the three-hundred-day working year."

Absenteeism due to sickness and accident when classified by sex and marital conditions shows some very interesting variations. "Single employees lost much less time than married persons, single males less than single females. Married males lost 2 per cent. more time than single males, widowed and divorced males 21 per cent. more, single females 40 per cent. more, widowed and divorced females 154 per cent. more, while married females lost 175 per cent. more.

"It is generally admitted that both married males and females show a lesser labor turnover than single persons, but a portion of this employment stability is sacrificed for the higher absentee rate of these married individuals, and from the standpoint of absenteeism alone, our experience indicates that married and divorced individuals are a considerable liability."

Absenteeism "by age groups indicates, first, that male employees lost on account of

sickness and accident on an average of five days, whereas female employees lost approximately eight and three-fourths days.

"Below the age of forty, the lost time by males is below the average male disability, while beyond the age of 45, males show a rapidly increasing morbidity rate. In the case of females, the rate remains less than the average up to the age of thirty, while beyond that age the rate increases. From an employment standpoint, therefore, we might well give careful consideration to women over the age of thirty, and men over forty."

Dr. Quinby goes on to consider disability according to nationality, according to physical examination classifications, by day of the week, and by months of the year. The article concludes with the list given below of the diseases causing lost time, and with figures upon the length of disability from sickness and accident.

Diseases causing lost time were as follows:

"General diseases—including tuberculosis, rheumatism, influenza, diphtheria, scarlet fever, typhoid, etc.—caused 1.46 days disability per person.

"Respiratory diseases — including colds, bronchitis, pneumonia, pleurisy, etc.—caused 1.26 days disability per person.

"Diseases of the digestive system caused 1.11 days disability per person.

"Ill-defined and unclassified sicknesses caused 1.09 days disability per person.

"Affections produced by external causes caused 0.41 days disability per person.

"Diseases of the bones and organs of locomotion caused 0.32 days disability per person.

"Diseases of the nervous system and organs of special senses caused 0.22 days disability per person.

"Diseases of the circulatory system caused 0.16 days disability per person.

"Non-venereal diseases of the genito-urinary system caused 0.15 days disability per person.

"Diseases of the skin and cellular tissue caused 0.09 days disability per person.

"The puerperal state caused 0.05 days disability per person.

"Malformations caused 0.005 days disability per person.

"Considered from the viewpoint of individual diseases, the more important follow in order:

"Influenza caused 0.718 days disability per person; colds, 0.53; tonsillitis, 0.341; bronchitis, 0.312.

"Pulmonary tuberculosis caused 0.24 days disability per person.

"Rheumatism caused 0.235 days disability per person.

"Appendicitis caused 0.171 days disability per person.

"Broncho- and lobar pneumonias caused 0.169 days disability per person.

"Pleurisy caused 0.095 days disability per person, while hernias caused 0.091 days disability per person.

"If we combined influenza, pulmonary tuberculosis, broncho- and lobar pneumonia, pleurisy, and other respiratory diseases, our experience in 1920 indicates that this group caused more than 35 per cent. of our total disability on account of sickness and accidents combined."—Katherine R. Drinker.

## INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

Critical Survey of Intelligence Testing. *Peter Sandiford.* Canadian Jour. Ment. Hyg., July, 1921, 3, No. 2, 37-46.—The first part of this paper consists of an historical review of the development of intelligence testing. The author goes on to elaborate on the nature of intelligence (is it multi-focal or unifocal?); on definitions as to what it is; on standardization of tests (often those from one locality are applied to a locality where the average of intelligence is higher or *vice versa*); and on methods of expressing the results of the measurements of intelligence (in which connection there are still two important unsettled problems; the amount of yearly increments of intelligence, and the age of maturity of intelligence).—M. Dent.

The Human Factor in Industry. *C. H. Northcott.* Indust. Management, Oct., 1921, 62, No. 4, 195-198; Nov., 1921, No. 5, 292-297.—One would expect to find the human factor in industry exalted in both history and practice, but the actual record is one of neg-

lect, despite the fact that industrial history is a story of the emergence of this human factor from a position of inferiority, and despite the instances of collective recognition of the place of human beings as the supreme factors in industry. The Clayton Act of 1914 establishing the principle that "the labor of human beings is not a commodity or article of commerce," and the world-wide consensus of opinion on the rights of labor represented by the principles laid down by the Peace Commission on International Labor Legislation in 1919, are expressions of this recognition of human rights in industry.

The human factor has now been exalted also by a wider social conception. The war has affected the attitude toward labor, and the impoverishment of the world by war has made it important to utilize the services of human beings to the utmost—a thing which cannot be accomplished under conditions that do not ennoble men and women. Men must be decently fed, clothed and housed before they can make their best effort.

We cannot properly treat human beings as a part of the mechanical system of industry. Man is greater than the machine. His driving force is in himself; he has a personality, and desires and aspirations which industry should meet. The exaltation of the human factor, therefore, implies more efficient use of machinery by men and women who know their own needs and limits, who have adjusted mechanized industry to themselves, and applied its products to their own physical and mental benefit.

In order to fit men and women into industry without waste and friction, account must be taken of their diversities, and in this regard probably mental qualities are even more important than physical. Industrial psychology must be applied, both to the study of fitness and to the analysis of the work itself.

Since manual toil consists of a multitude of muscular movements, attention must be given to the quality of these movements. Opposition arises from the fear that this form of study will turn men into automatons, but this fear is misguided. All important operations should be analyzed and the best movements taught to each beginner; experience has shown that this is a practicable plan. In this connection attention should be given to the laws of practice, and it may be said that the desire of many persons to work along their own lines is often in direct opposition to their best interests.

Account must be taken also of fatigue and its causes, since there is an enormous waste from neglecting this factor. In fatigue needless motions are an element to be considered, and the length of the working day is an important one; it is hard to find any justification for a day longer than eight hours. In regard to the essential factor of rest periods in preventing fatigue, the fact that different individuals probably demand different treatment should be taken into consideration. There is a natural rate of working and a natural rhythm for each individual and fatigue is caused when operations are not adjusted to these; but at the same time it should be known that it is quite possible for a rhythm to become habitual that is at once more fatiguing and less productive than one that is faster. Noise and vibration cause fatigue, and the factors of lighting and ventilation still need to be more generally considered. (It is stated in a report of the British Industrial Fatigue Research Board that an output increase of 12 per cent. might be expected in the tin-plate industry in South Wales from more efficient ventilation.) Humidity also is a potent factor in fatigue. In a word, man, as a purely physical being, needs much consideration if he is to play his part in industry.—G. E. Partridge.

## INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

Medical Department Helps Cafeteria. *E. H. Ansell.* Hosp. Management, Oct., 1921, 12, No. 4, 56, 58, 60.—During the war the author served upon the Food Administration Board and, as his work embraced the industrial and school lunches in New England, splendid opportunity was afforded him to study luncheon methods, equipment, menus and finances. Consequently, upon returning to his position with the New England Telephone Company at the close of the war he was able to put his experience to practical use.

It is the author's opinion that the cafeteria patronage of the New England Telephone Company is due to (1) prices that entice, (2) the appetizing appearance of the food, (3)

the quality of the supplies, and (4) the variety of the menus. There are seventy-five different menus, a sample of which is given, with prices included. Each menu is supplemented by cooking instructions to the matrons so that all foods may be uniformly prepared. Formerly the menu showed each food item separately, but the present menu provides for food combinations. This change in system is due to the fact that during the last year of the war the medical department reported that the health of the young women employees of the company was from 10 to 20 per cent. below par, and recommended that larger portions be given in the cafeterias. When the matter was referred to Mr. Ansell, he made rather extensive observations in the company's lunchrooms and discovered that only about 18 per cent. of the women employees were selecting a good working ration. It seemed evident to him that increasing the size of the portions would not solve the problem, but another solution was found—namely, that of making attractive combinations covering meat portions plus bread and butter for the same price that was formerly charged for meat alone. Frequently, a side order of spinach or carrots is added in order to make a well-balanced ration. In addition, the price of milk was reduced to 2 cents per glass and the size of the glass increased from 8 to 10 ounces. In order to meet the requirements of employees who bring a lunch and who wish to supplement it, various items on the menu are sold separately.

A marked increase in the health of the company's employees was quickly noticed after this change in menu—a factor which supports the author's contention that there should be closer co-operation between the luncheon and the medical department executives. In closing, the author emphasizes the importance of industrial lunchrooms as educational measures and outlines the opportunities open to industrial plants for physically building up their forces.—M. C. Shorley.

Serving Meals at a Loss. *E. Hobart.* Factory, Nov., 1921, 27, No. 5, 704.—At the White Motor Company a soup kitchen, two cafeteria lunch counters and a restaurant are maintained. "An effort is made to serve the best and most healthful meals and to give the most efficient service. The restaurants and cafeterias are run at a loss, which is taken care of by a special fund set aside for this purpose by the company."—M. Dent.

This Provides Recreation. *T. W. Altman.* Factory, Nov., 1921, 27, No. 5, 700.—"To provide a suitable place for recreational activities, the Clark Equipment Company has a model theater, built right in among the factory buildings . . . The auditorium of the theater will comfortably seat a thousand people. It has a large stage with footlights, and is fully equipped." The theater is used for many purposes, dances, musicales, "movies," etc., and is operated without profit.—M. Dent.

## INDUSTRIAL HEALTH LEGISLATION: COURT DECISIONS: WORKMEN'S COMPENSATION AND INSURANCE

The British Industrial Court. *W. Mackenzie.* Internat. Labour Rev., July-Aug., 1921, 3, Nos. 1-2, 41-50.—The writer reviews the efforts made in Great Britain to provide for peaceable settlement of industrial differences, and traces their history back to the Elizabethan Statute of 1562. An attempt was made during the early part of the nineteenth century to introduce compulsion into arbitration, but this was abandoned in favor of persuasion and argument, until during the Great War "the element of compulsion in arbitration was again introduced and this time with effect." The Committee on Production was given power to deal with industrial disputes, and this committee accumulated an extensive knowledge of industrial conditions, and in the course of its work made 3,754 awards.

The successor of the committee as an arbitration tribunal was the Interim Court of Arbitration (established under the Wages Act of 1918), which made about 850 awards, only three of which were disputed and followed by interruption of work. The Interim Court came to an end with the passing of the Industrial Courts Act in November, 1919, and except as to temporary action in regard to questions of prescribed rates, all compulsion was done away with. The Industrial Courts Act establishes arbitration machinery, and

also provides Courts of Enquiry. The aim is to give the parties of a dispute as wide a choice as possible as to the kind of tribunal to which the difference shall be submitted. A permanent Industrial Court is set up, but disputes may also be referred to persons or boards appointed by the Minister of Labor, or to a board of arbitration nominated by the parties to the dispute. The Industrial Court itself consists of thirteen persons, appointed by the Minister of Labor, and constitutes an independent tribunal.

Arbitration as provided for in the Industrial Court is on a wholly voluntary basis. The parties must agree to refer to the court, and the finding of the Court depends for its observance on the honor and civic sense of the applicants. Experience has shown that appeal to a sense of fair-play is practicable, since the number of repudiated awards is almost negligible.—G. E. Partridge.

Workmen's Compensation for Loss of One Eye. *Siegrist.* Abstracted as follows from Schweiz. med. Wchnschr., Sept. 1, 1921, 51, No. 35, 801, in Jour. Am. Med. Assn., Nov. 5, 1921, 77, No. 19, 1528.—"The Swiss social insurance has been in the habit of allowing 10 per cent. compensation for the loss of an eye for the mutilation, with an additional 10 to 23 per cent. for the incapacity, and nothing more. This has lately been changed to 10 per cent. for the mutilation and nothing more unless vision is lost in the other eye. If this occurs from an insured mishap, the workman receives 100 per cent.; if from sickness or an uninsured accident, he receives 50 per cent. If vision is not totally lost, the percentage is modified to correspond. Siegrist discusses these regulations. The Swiss Ophthalmologic Society appointed a committee to study the matter, and adopted resolutions approving the new regulations, but demanding a higher rate for the mutilation, 20 or 25 per cent. according as the eye had been enucleated or not. The society also urged that opportunity for revision be allowed at any time."—C. K. Drinker.

Report of Investigation into the Operation of the British Health Insurance Act. *William T. Ramsey* and *Ordway Tead.* Am. Labor Legis. Rev., Sept., 1921, 11, No. 3, 233-278.—"It may be said at once that in the main and considering the handicaps and obstructions suffered during five years of war the act is in reasonably successful operation and is beginning to produce some of the benefits that were initially urged in its behalf.

"In the second place the affected groups in the community are now working the act with a remarkable degree of co-operation and with an all but universal recognition of the value of the legislation. Few in the community would seriously advocate or even contemplate its repeal or withdrawal. The tendency and common desire is in quite the opposite direction to make the act in fact as well as in name a national act which will really assure good health throughout the country.

"In the third place, as this report will presently develop, it is highly probable that much may be learned from the failures and the shortcomings of the present operation; and any rigid copying of the British act would certainly be quite unwarranted when the peculiar conditions under which it has developed are understood.

"Points at which the British experience can most certainly provide a useful warning are the following:

"1. The cash benefits should not be paid through approved societies, but through local bodies publicly constituted.

"2. The cash benefit should be at least 50 per cent. of wages.

"3. The medical benefits should not be limited to the insured workers, but should extend to their families.

"4. Hospital care, consultant services and specialized diagnostic facilities in the form of clinics and laboratories should not be left out of the plan, but should be incorporated as part of the medical benefit."

The report amplifies and explains the above statements.—M. Dent.

## INDUSTRIAL MORTALITY AND MORBIDITY STATISTICS

Sickness among Telephone Employees in Italy. Internat. Labour Rev., Nov., 1921, 4, No. 2, 143-144.—Investigations of sickness among the staff of the state telephone service in the Florence district from 1912 to 1920 show that the average individual sickness rate

in the permanent male staff (given for the years 1917-1919 for the whole country) was 41.08, and in Florence for the years 1912-1919 11.55 for the permanent staff and 9.25 for the temporary staff. The corresponding averages for women were 53.3, 32.84, and 13.67. The writer concludes that with efficient health and sanitary inspection the averages could be reduced by one-third, so that a satisfactory average sickness rate may be taken as 13.6 for men and 22.18 for women.—G. E. Partridge.

Sickness and Death Rates among German Printers. Internat. Labour Rev., Nov., 1921, 4, No. 2, 142-143.—In its report for 1920 the German Printers' Union presents statistics in regard to 18,439 cases of sickness. A table shows that of a total of 6,892 cases (how selected?) the largest class is malign tumors, 1,479 cases; followed by nervous diseases, 1,442; affections of the stomach, 934; gout and rheumatism, 805; respiratory diseases, 712; heart diseases, 420; affections of the eye, 310; affections of the bones and joints, 305; affections of the bladder and intestines, 260; lead poisoning, 204; tuberculosis, 21.—G. E. Partridge.

The Mortality of Masons. *G. Gherardi.* Il Lavoro, Sept. 30, 1921, 12, No. 5, 130-136.—The masons in Italy have a mortality lower than that of males above the age of 15 years, 16.1 per thousand as against 18.7. This speaks for the healthfulness of their trade, which is carried on out-of-doors, is not as strenuous as many other sorts of labor, and permits of the harmonious development of the whole body. There is no evidence of any occupational disease among them, but the accident rate is not only much higher than that of other adult males, but has undergone a greater proportional increase during the last ten years than has that of the male population in general. The mortality from accidents for men above 15 years was 42.8 per thousand during twenty years ending 1916; for the masons it was 79.3. The rate for the first class had increased during the second decennium from 39.8 to 45.8, but for the masons from 66.4 to 91.7. The question is raised whether the excessively high rate indicates that masons' work is growing continually more dangerous, but the author believes that this is not true, and thinks that the cause lies in greater recklessness. He urges the building trades to undertake the same intensive efforts for the prevention of accidents which in the steel industry have resulted in a reduction of casualties from 1,392 in 1906 to thirty-nine in 1911. The chief dangers in the building trades are to be found in faulty construction of scaffolds, lack of adequate supervision, and failure to select the most dependable workmen for the most dangerous jobs.—Alice Hamilton.

# ABSTRACT OF THE LITERATURE

OF

# INDUSTRIAL HYGIENE

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## GENERAL

PROBLEMS OF INDUSTRIAL HYGIENE IN RELATION TO PUBLIC HEALTH. *Sir Thomas Oliver.* Jour. State Med., Nov., 1921, 29, No. 11, 321-332.—Women have entered industry in large numbers to stay, and they constitute a distinct problem. Welfare work has been an important aid in handling this problem. Capacity for work decreases after the sixth month of pregnancy up to parturition, after which the curve rises to normal about three months after childbirth. Women should be spared heavy work during the last two months of pregnancy. There is nothing to show that ordinary factory work unfits women for domestic life.

Vocational fitness of men and women should be considered early so that labor turnover and "misfits" may be reduced to a minimum. Experience in England and the United States shows that disability increases with age after 35 or 40 years. Industrial accidents are too high, and steps should be taken to procure reduction by securing the active co-operation of all concerned. Return to work after illness or accident should be gradual. The mental diversion and development of the modern factory worker should be looked to if constructive progress is expected.—Barnett Cohen.

INDUSTRIAL WASTES. Abstracted from Chem. Met. Engin., 1921, Vol. 25, in Chem. Abstr., Oct. 20, 1921, 15, No. 20, 3534.—The following articles are listed for the benefit of interested readers: "Human Waste in Industry," by Harry E. Mock, p. 369; "Waste Due to Poor Engineering and Management," by Dexter S. Kimball, p. 375; "The Educational Waste in Industry," by Hollis Godfrey, p. 378; "The Rôle of Research in Waste Elimination," by Harrison E. Howe, p. 379; "Waste Due to Lack of Standardization of Chemicals," by Wallace P. Cohoe, p. 383; "The Personal Problem: To Eliminate the Waste of Human Effort," by L. B. Hopkins, p. 385; "Disclosing

Waste through Better Cost Methods," by Ernest J. Wessen, p. 389; "The Elimination of Construction Wastes," by George W. Burpee, p. 394; "Some Consideration on Fire Waste," by Nicholas Richardson, p. 397; "Location as a Factor in Eliminating Industrial Waste," by Victor V. Kelsey, p. 401; "Reduction of Waste through Accident Prevention," by L. A. DeBlois, p. 403; "Elimination of Waste in Industry Due to Poor Lighting," by Ward Harrison, p. 407; "Eliminating Manufacturing Wastes with Machinery," by J. E. Hires, p. 410; "Elimination of Waste in Industrial Power Plants," by David M. Myers, p. 413; "The Elimination of Waste in Marketing," by William R. Basset, p. 420; "Wastes in Litigation," by Wellington Gustin, p. 423; "Eliminating Waste and Nuisance in Smoke, Fume and Gas," by P. E. Landolt, p. 428; "The Wastes Caused by Carelessness," by Philip DeWolf, p. 433. In addition to the papers noted here this special number of *Chemical and Metallurgical Engineering* contains a number of brief articles on wastes in specific industries which are referred to separately in the appropriate sections of this number of *Chemical Abstracts.*

## SYSTEMIC OCCUPATIONAL DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

VISCEROPTOSIS: NORMAL INCIDENCE: A PRELIMINARY REPORT. *John Bryant.* Jour. Am. Med. Assn., Oct. 29, 1921, 77, No. 18, 1400-1402.—"1. Visceroptosis is, in general, not progressive with age. This is due to the fact that, although the percentage of ptosis of certain viscera increases with age, this percentage increase is offset by a decreasing frequency with age in respect to other viscera.

"2. Visceroptosis affecting one or more organs was present to some extent in 48 per cent. of all cases examined, it being extreme in 10.2 per cent. of the males and 19.7 per cent. of the females.

"3. Visceroptosis affecting the liver, right and left kidney, stomach and pylorus, is acquired.

"4. Visceroptosis affecting the large intestine is in both sexes largely congenital or developmental. The percentage frequency of ptosis of certain portions of the large intestine does, however, further increase with age in both sexes. The greatest discrepancy between the male and female in regard to the percentage frequency of coloptosis in the adult occurs at the ileocecal valve. Thus, this portion of the colon shows an extreme degree of ptosis in 12.1 per cent. of the males of all ages; this contrasts with an extreme degree of ptosis at the ileocecal valve in 39.4 per cent. of the females of all ages.

"5. No normal standard of frequency of visceroptosis, based on unselected material, exists.

"In the absence of such a normal standard, proper evaluation of the degree of deviation reported in any selected roentgenologic or other series of cases is impossible.

"A standard of frequency of visceroptosis which may be considered adequate until corrected by future investigators is made available in tabular form in the present article." —C. K. Drinker.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

INDUSTRIAL POISONINGS AND THEIR PREVENTION. *Ernst Brezina.* Abstracted as follows from Chem. Ztg., 1921, Vol. 45, 599-602, 624-626, 647-649, 694-696, in Chem. Abstr., Nov. 10, 1921, 15, No. 21, 3685.—"An extended lecture on individual toxicology covering many inorganic and organic poisoning agents, symptoms, tests, methods of treatment, means for prevention, statistics and bibliography."

BLAST FURNACE GAS POISONING. *Otto Johannsen.* Abstracted as follows from Stahl. u. Eisen, 1921, Vol. 41, 1141, in Chem. Abstr., Oct. 20, 1921, 15, No. 20, 3438.—"The dulling

of the mental faculties observed in several cases of severe blast furnace gas poisoning has nothing to do with the purity or kind of purification of the gas. This phenomenon is not caused by an unknown poison, but is a typical symptom of CO poisoning. Although pure gas is just as dangerous as crude gas, and blast furnace gas is being more and more widely used, no increase in gas poisoning is to be feared because of better arrangements for its use."

Poisoning from Acetylene. *S. Pontoppidan.* Abstracted as follows from Ugeskrift for Laeger, Sept. 1, 1921, 83, No. 35, 1222, in Jour. Am. Med. Assn., Nov. 26, 1921, 77, No. 22, 1778.—"The symptoms and circumstances indicated phosphoretted hydrogen poisoning in the young mechanic who had been using a blow-flame of oxygen and acetylene. Acetylene gas is supposed to be harmless when pure, but it often contains phosphoretted hydrogen, and the symptoms presented by the young man indicated poisoning with this substance. They included vomiting, headache, dizziness, insomnia, paresthesias and nervousness and slight jaundice. The importance is obvious of detecting this poisoning in time to ward off serious injury of parenchymatous organs. Harbitz states that a few tenths per thousand of phosphoretted hydrogen are enough to cause fatal poisoning, and the acetylene gas in common use frequently contains it. (The Danish term used is *fosforbrinteforgiftning.*)"—C. K. Drinker.

Properties and Uses of Para-Dichlorbenzene. *Witt.* Zentralbl. f. Gewerbehyg., Oct., 1921, 9, No. 10, 244-245.—This readily volatile solid is being used in industries as a substitute for the common naphthalene moth balls. It is known to cause discomfort, but not known to be poisonous. A death is reported as possibly due to fainting from dichlorbenzene fumes, followed by asphyxiation with gas. Caution is urged in the use of the substance.—E. L. Sevringhaus.

Case of Gasoline or Gas Poisoning. *W. M. Kraus.* Arch. Neurol. and Psychiat., Dec., 1921, 6, No. 6, 707.—"The patient had been working about a gas engine, exposed to the fumes from the exhaust. He started at that particular job in August, 1920, and entered Bellevue Hospital in June, 1921. At that time he was troubled with numbness, weakness and coldness in the legs, hands and forearms. This trouble had begun the previous February, when he complained of dizziness, some nausea, frontal headache and general malaise. He had had no stomach attacks before that. His legs slowly became weaker, so that by April he could not walk. He had no other symptoms.

"Examination revealed that his cranial nerves were normal. He had a bilateral hypesthesia of a stocking variety almost to the knees, and in the toes a slight defect in sense of position. He was unable to stand. Six blood Wassermann tests and three spinal fluid Wassermann tests were negative. The last blood Wassermann test was followed in about three weeks by administration of arsphenamin.

"At present he shows marked atrophy of all extremities. He has no more fibrillary twitching. His superficial reflexes are still present. He shows no signs of involvement of any of the other nerves.

"About three years ago three men in one garage complained of the same symptoms, and they told me at the time that this disease was not infrequent among chauffeurs. Since then I have had another case, but it has not shown the profound atrophy found in this case."—M. Dent.

Industrial Respirators. *Leonard Levy* and *D. W. West.* Jour. Soc. Chem. Industry, Oct. 15, 1921, 40, No. 19, 234T-237T.—This paper was presented before the June meeting of the London Section of the Society of Chemical Industry. In it the authors show the transition from war gas masks to industrial masks applicable to present-day industries. Besides portability and comfort to the wearer, industrial masks or respirators must contain absorbent media of certain "capacity and reactivity" dependent on the substances in the atmosphere to be breathed. The authors give physiological and chemical data on the detection and absorption of toxic substances in the respirators recommended. They describe respirators for (1) ammonia, in which crystalline copper sulphate is the absorbent; (2) neutral vapors, for which activated vegetable charcoal is the absorbent; and (3) acid fumes, for which special alkaline granules, often with a highly activated charcoal, are necessary. With acid fumes a high degree of reactivity

is essential as the gases encountered are usually highly toxic.

Particulate clouds require special filters and absorbents for which no general rule can be made. Where protection to the eyes is required the mask must be modified accordingly.

Carbon monoxide has been successfully removed only by oxidation. Results are cited which were obtained by the American Chemical Warfare Society when using a catalyst of finely divided mixed oxides of manganese, copper, cobalt, and silver, with a preliminary layer of calcium chloride to absorb moisture. For industrial purposes a detector is recommended which will produce a lachrymatory effect. The authors claim that iodine pentoxide and fuming sulphuric acid impregnated into pumice give a liberation of iodine sufficient to produce this effect. The discussion which follows shows that this respirator and detector is limited to atmospheres in which there is no poverty in oxygen.—Philip Drinker.

Respiratory Apparatus for Protection against Carbon Monoxide. *A. Desgrez, H. Guillemard, A. Hemmerdinger* and *A. Labat.* Chimie et Industrie, Oct., 1921, 6, No. 4, 536-538.—This respirator is based on the oxidizing reaction of iodine pentoxide and sulphuric acid on carbon monoxide. The efficacy of the active agents is enhanced by the fineness of the pumicestone granules on which these reagents are deposited. A size of 4 mm. is recommended. The granules are first impregnated with sulphuric acid of at least 66° Bé. strength, to which fuming sulphuric is often added, and the iodine pentoxide added with shaking. Eighty gm. of iodine pentoxide with 25 c.c. of acid are required for treating 270 gm. of pumice. Iodic acid is sometimes used but the iodates have not been employed with success.

The apparatus may be made with or without valves. In the latter case the filtering box is parallelopipedic in shape, and made of two unequal metallic compartments connected at the bottom, but separated at the top by a partition. The larger compartment is open to the atmosphere and filled with the oxidizing mixture, while the smaller compartment is directly connected with the respiratory passages and is filled with granulated oxylith to serve the threefold function of absorbing moisture from respiration, absorbing iodine and carbon dioxide, and furnishing oxygen. The authors claim that this apparatus, of 1.5 liters' capacity, has been used successfully for one hour by a subject breathing air containing 10 per cent. carbon monoxide.

The respirator with a valve functions similarly but is made in two separate compartments connected by a tube which is not put in place until the apparatus is ready for use. By storing oxidizing and absorbing reagents in separate compartments the oxidizing reagent is kept free from moisture, which is essential, as the mixture is strongly hygroscopic. The authors claim priority of the French over the Americans in the development of this respirator and state that the latter employ only one compartment for the oxidizing and absorbing reagents which results in the metal of the compartment being attacked.—Philip Drinker.

Bureau of Mines Experimental Tunnel for Studying the Removal of Automotive Exhaust Gas. *A. C. Fieldner* and *J. W. Paul.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2288, Oct., 1921.—This paper gives a description of the tunnel constructed near Pittsburgh. While designed particularly for investigations bearing on the proposed Hudson River vehicular tubes, the studies to be conducted at Pittsburgh comprise: "(1) The diffusion of exhaust gases in the cross-section of the tunnel by transverse ventilation, bottom to top, and top to bottom; (2) temperature and smoke conditions as affected by the operation of motor cars; (3) physiological and psychological effects of temperature, exhaust gases and smoke under operating conditions; (4) final check on all previous investigations and practical demonstration of the solution of the problem of ventilating tunnels traversed by vehicles."

The Pittsburgh tunnel will be, in effect, an "underground oval track," with an axial length of 400 feet, a cross section 9 feet wide and 8 feet high, a 3-foot air duct above the ceiling and a 2½-foot duct below the floor. Ample and elaborate provisions are made for sampling the air, for the determination of air flow, humidity, temperature, etc. Physiological examinations will be made contemporaneously with the physical and chemical observations.—Philip Drinker.

A Possible Source of Lead Poisoning. *A. F. G. Cadenhead* and *A. G. Jacques*. Abstracted as follows from Can. Chem. Met., 1921, Vol. 5, 260, in Chem. Abstr., Nov. 10, 1921, 15, No. 21, 3685.—"The object of the experiments was to demonstrate whether Pb accidentally mixed with smoking tobacco is carried over in the smoke. By duplicating the conditions present in pipe smoking it was proved that a very small proportion of Pb would be inhaled, but most of it remains in the ash and tar as Pb and PbO."

Relation of Lead Poisoning in Utah to Mining. *Arthur L. Murray*. U. S. Bur. Mines, Reports of Investigations, Serial No. 2274, Aug., 1921.—"The case rate from lead poisoning in Utah is so far out of proportion to the death rate, that the death rate cannot be taken as an index to the number of cases prevalent. From the reports received during this investigation, the metal-mining industry as represented by the metal mines and smelters is responsible for at least 95 per cent. of the industrial lead poisoning in Utah. This was to be expected, as mining and smelting are among the principal industries of the State, with relatively few other industries in which workers might be exposed to salts of lead."

Dangerous and Unhealthy Industries. Statutory Rules and Orders, No. 1443, London, Aug. 23, 1921, pp. 6.—This pamphlet contains regulations for the manufacture of certain compounds of lead, namely, any carbonate, sulphate, nitrate or acetate of lead, and states definitely the precautions to be observed by occupiers and persons employed.—M. C. Shorley.

✓ The Use of White Lead in Painting. Internat. Labour Office, Studies and Reports, Series F, No. 4, Oct. 24, 1921.—The movement against the use of white lead originated in France and spread from that country to Germany, and now several countries have laws prohibiting or regulating the use of the material. A regulation which came into force in Germany in 1906 contained several provisions about the use of lead, but did not prohibit it. In 1910 the Society for Social Reform presented a petition to the Ministry of the Interior asking for a far-reaching prohibition of the use of lead paints, and the Minister of Public Works issued a circular in 1913, which was, however, only advisory.

The most far-reaching prohibition is contained in a regulation of the Central Railway Office ordering substitution of non-poisonous paints for white lead in all coach-building works. This is in contradiction of an order issued in 1907. The governing body of the International Labour Conference held in Washington in 1919 has placed the prohibition of white lead in painting on the agenda of the 1921 conference.

Opinions differ in Germany about substitutes for lead paints. Most workers and their representatives state that zinc oxide and lithophone are satisfactory substitutes, but they have not sufficiently proved their case. In indoor painting, it seems to be agreed, white lead is not indispensable, at any rate for top coats, but there is evidence that for outdoor work it is necessary. The commercial objections, therefore, are not valid, and the only remaining reason for the prohibition is the danger of lead poisoning.

Opinions in Germany on the danger from white lead vary greatly. The master painters' guilds, so far as asked, report almost unanimously that the number of cases of poisoning has greatly decreased in recent years. The sick fund of the Dortmund Painters' Guild, out of an average of 1,000 members, had six cases of lead poisoning in 1911, and none in 1919 when the number of members was 500. Statistics of two other funds show a decrease from 1903 to 1911. But no statistics of the pre-war period are entirely reliable, since it is now shown by blood tests that diagnosis of lead poisoning had previously been very loose.

If, despite all preventive measures, cases of lead poisoning still occur, they are principally due to the fact that it has been impossible as yet to abolish carelessness, stupidity and lack of cleanliness as completely as could be wished. Lehmann and Koelsch state that the whole question of lead is more or less a question of cleanliness.

If there are difficulties in the supervision of regulations enforcing prohibition of the use of white lead, there would be still greater difficulty if the use of colors containing a certain proportion of lead were allowed, as is provided for in the memorandum of the International Labour Office. It has been shown by experience

also that the worker is generally comparatively careful in using paints which he knows to be poisonous, but the less poisonous the paint the less care will be taken.—G. E. Partridge.

The Pharmacologic Action of Lead in Organic Combination. *E. C. Mason.* Abstracted as follows from Jour. Lab. Clin. Med., 1921, Vol. 6, 427-453, in Chem. Abstr., Sept. 20, 1921, 15, No. 18, 3145.—"$(C_2H_5)_3Pb\text{-}Pb(C_2H_5)_3$ and its salts stimulate the higher centers of the central nervous system, the injection of 0.0025-0.0050 g. producing convulsions in a medium-sized dog. An extreme fall in blood pressure follows the first injection, owing to stimulation of the inhibitory vagus center for the heart, sudden dilatation of visceral vessels, and direct depressant action on the heart. A prolonged rise in blood pressure follows subsequent injections, owing to constriction of visceral vessels and stimulation of the sympathetic nerves to the heart. Respiration is stopped by first injections and increased by subsequent ones. Dyspnea occurs, owing to direct action on the respiratory center. Intestinal activity is increased. Kidney and spleen volumes increase first and then decrease. Subsequent injections produce only decrease."

Importance of Industrial Medicine to the Community. *Sir Kenneth Goadby.* Lancet, Sept. 3, 1921, 201, No. 5114, 489-491.—One is struck with the frank opposition of employers and employees in matters of health innovation. An example of this is in the so-called questionnaire published by the International Labour Office denying that dust is a serious cause of poisoning in the painting trades.

The health of painters and the diseases from which they suffer is a much debated problem. The absence of a high incidence of diseases of the alimentary and nervous systems, and the presence of a high incidence of diseases of the respiratory tract are difficult to reconcile with the supposedly great amount of lead poisoning among painters. In an examination of white lead workers and painters the average blood pressure was found to be higher than that of lead workers. This higher arterial tension of painters is the more striking since less muscular effort is required to wield a paint brush than to carry half-hundred-weights of lead. This appears to support the growing opinion that the cause of disease is in the volatile portions of the paint rather than in its solid constituents.—M. Dent.

Trinitrotoluene Poisoning. *L. Lewin.* Abstracted as follows from Arch. Exper. Path. Pharm., 1921, Vol. 89, 340-359, in Chem. Abstr., Oct. 10, 1921, 15, No. 19, 3332.—"The local and generalized reactions of the body to trinitrotoluene are described. In the animal body the compound is readily decomposed; it cannot be found in either blood or urine. Hematin formation and decrease in erythrocyte counts are observed."

The Anatomical Diagnosis and Histology of Phosphorus Poisoning. *Elsie Petri.* Abstracted as follows from Frankfurter Z. Path., 1921, Vol. 25, 195-215, in Chem. Abstr., Sept. 20, 1921, 15, No. 18, 3137.—"The liver in phosphorous poisoning cannot be distinguished from acute yellow atrophy. By the use of elective histochemical methods in five cases of phosphorus poisoning, lipoids were demonstrated in the liver, kidneys and stomach belonging to the group of phosphatids, as well as neutral fats and mixtures of neutral fats and lipoids. The presence of lipoids speaks against the assumption that the fat in the liver is entirely infiltrated fat. There must be in addition a fatty phanerosis. Phosphorus belongs to the toxic substances of known and unknown origin which produce acute yellow atrophy, and the anatomical and clinical picture of phosphorus poisoning is not a separate entity but belongs to the large group associated with acute yellow atrophy of the liver."

Fatal Intoxications by Arsenic in Viticultural Districts. *Paul Cazeneuve.* Abstracted as follows from Bull. acad. med., 1921, Vol. 85, 660-671, in Chem. Abstr., Sept. 20, 1921, 15, No. 18, 3147.—"Several cases of As poisoning are reported, due to the use of arsenic compounds in the cultivation of grapes."

Action of Mercury. *W. Salant* and *N. Kleitman.* Abstracted as follows from Proc. Soc. Exper. Biol. and Med., 1921, Vol. 18, 249-250, in Physiol. Abstr., Oct.-Nov., 1921, 6, Nos.

7 and 8, 453.—"The action of mercury benzoate, succinate, and acetate, injected intravenously into dogs and cats in a concentration of 1:5000, was studied. Small doses increased the frequency and depth of respiration; larger doses produced the opposite effect, as also did repeated small doses. Small doses either had no effect upon the blood pressure, or caused a temporary rise; repeated small doses caused a fall in blood-pressure and slowing or arrest of the heart, the fall in pressure being less abrupt and lasting longer if the vagi had been cut previously."—Mckeen Cattell.

## DUST HAZARDS AND THEIR EFFECTS

Tobacco Pneumokoniosis. *F. Palitzsch.* Zentralbl. f. Gewerbehyg., Oct., 1921, 9, No. 10, 225-229.—This article is a clinical report and discussion of a case of chronic pulmonary affection. The varied symptoms, the X-ray findings, the negative findings for tuberculosis, and the long and favorable course are explained on the diagnosis of pneumokoniosis. The exciting cause is believed to be the continued inspiration of fine tobacco dust from a machine for grinding cigarette filling. E. L. Sevringhaus.

Pneumokoniosis and Asthmatic Attacks in Woodworkers. *P. Pincherle.* Il Lavoro, Oct. 31, 1921, 12, No. 6, 181-182.—There is very little concerning wood dusts in the literature of pneumokoniosis. Kurt Gade of Rostock, examining wood dust under the microscope, found particles rich in sharp points, capable of injuring the epithelium of the nose and also of the trachea and bronchi. It is chiefly this mechanical effect that is of importance, although there is also a chemical action in the case of such woods as mahogany, satin wood, sandalwood, and teak. The author reports a case of asthma following the aspiration of wood dusts. The sputum did not show the findings pathognomonic for asthma, *i.e.*, Curschmann spirals, Charcot-Leyden crystals, nor was there any reason to suspect the presence of a toxic agent or of bodies provoking anaphylaxis. The cause of the asthma was a chronic bronchitis provoked by the breathing of wood powder. Twenty woodworkers were then examined, fourteen of whom showed morbid conditions of the respiratory tract, *viz.*, seven with bronchial catarrh more or less intense, and seven with asthmatic attacks. Curschmann spirals were found twice, Charcot-Leyden crystals once.—Alice Hamilton.

## OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Preventing Preventable Diseases in New York City. Occupational Clinic. *L. I. Harris.* New York City Dept. Health, Month. Bull., Sept., 1921, 11, No. 9, 214-221.—During 1920, 17,143 food-handlers were examined in the clinics of the Bureau of Preventable Diseases of New York. Comparison with 55,673 examinations made by private physicians during the same time leads to the suspicion that "the private physicians are not all contributing conscientiously to the protection of the public health from food-handlers who may be affected with communicable diseases." Of a total of 16,484 cases suitable for computation, 28 per cent. were found with physical defects of significant character. Some of these were excluded outright from work as food-handlers and some were put on probation.

In Manhattan, 123 food-handlers of the 4,780 examined were placed on probation as suspected of having active tuberculosis, or because of signs of apparently arrested tuberculosis. The same proportion holding, there are 19,000 or more such cases in the city of New York. A proportion of 65 per 10,000 examined showed an apparently active syphilitic condition. It is estimated that there are about 10,000 cases of latent or inactive syphilis among the 750,000 food-handlers of the city. On the same presumptions as regards the relation of the number tested to the whole group, there would be somewhat more than 21,000 "suspected typhoid carriers." The examinations for gonorrhea were too incom-

plete to give satisfactory estimates. Parasitic skin affections and some miscellaneous conditions caused 522 probations.

A table is presented showing in detail the different disease groups, the records of examinations made by private physicians during 1920 for each district, and on this evidence it is concluded that "since the examination of food-handlers has been demonstrated to be an activity of the Department which is of vital importance as a public health measure, it would seem to be necessary, in the interest of the public welfare, to discontinue delegating this important function to private physicians."

Activities of the veterinary service of the Bureau are also briefly summarized, and there are some details in regard to the work of nurses.—G. F. Partridge.

THE MANAGEMENT OF A DIPHTHERIA OUTBREAK IN A PRIVATE SCHOOL. *E. C. Fleischner* and *E. B. Shaw*. Jour. Am. Med. Assn., Nov. 26, 1921, 77, No. 22, 1714-1717.—"The following facts may be given as a means of controlling a diphtheria outbreak in a boarding school:

"1. Immediate isolation and treatment of the sick children.

"2. Immediate, carefully supervised nose and throat cultures on all members of the school.

"3. Schick tests with proper controls on all members of the school within twenty-four hours.

"4. Administration of 1,000 units of antitoxin subcutaneously to all children having positive Schick reactions at the end of forty-eight hours.

"5. Reculture of noses and throats of all contacts two days after the primary culture.

"6. Isolation of all ill children from the healthy children and from the true diphtherities until a positive diagnosis is established.

"7. Immediate isolation of all the carriers and, when it is possible, employment of toxicity tests to avoid the exposure of those children having avirulent diphtheroids to those with true virulent organisms.

"8. When the outbreak is controlled, the conferring of active immunity on all children with positive Schick reactions by the proper injections of toxin-antitoxin mixtures."—C. K. Drinker.

CLINICAL ASPECTS OF ANKYLOSTOMIASIS. *Ignazio di Giovanni*. Il Lavoro, Oct. 31, 1921, 12, No. 6, 175-178.—At the sixth Congress of the Sicilian Medical Society, di Giovanni discussed the question whether it was possible to diagnose ankylostomiasis without the aid of the microscope, or whether, as is apparently held by physicians of the Rockefeller Foundation, there is a clear-cut, clinical picture of this infection. His investigation was carried on in the mines of Tallarita and Cozzodisi with 1,000 miners each, a large percentage of whom are infected. The majority denied that they felt any symptom of ill health and only after they had been assured that they harbored the parasite would they admit a sense of weariness in their legs. This was as a usual thing the only symptom, and although many of them showed more or less pallor of the face and of the visible mucous membranes, still this was also noted in individuals without parasitic infection, and it is, according to the author, a true professional stigma for sulphur miners which he believes to be referable to the hemolytic action of sulphur and its acid derivatives.

At the Central Station for the Prevention of Ankylostomiasis in Caltanissetta, the author examined 146 miners with ankylostomoanemia of marked degree, but even among these the clinical picture did not present any element which could arrest attention as of pathognomonic significance. The only constant symptom noted was anemia. The author dissents from the school of Padua, the school of Cairo, and the American investigators in that he was never able to detect albumin in the urine (supposedly constant in ankylostomo-anemia), nor blood in the feces, much less intestinal hemorrhage, nor any characteristic disturbance of the gastro-intestinal tract or of any organ. He concludes that the only constant picture is that of anemia, with its usual train of phenomena.

The blood findings are not diagnostic, consisting only in a diminution of the number of erythrocytes, increase of lymphocytes, low hemoglobin, eosinophilia, and poikilocytosis. It is absolutely essential to subject the dejecta to microscopic examination in order to arrive at a diagnosis of ankylostomiasis.—Alice Hamilton.

Report of the United States Interdepartmental Social Hygiene Board for the Fiscal Year Ended June 30, 1921. Washington, Govt. Printing Office, 1921, pp. 198. —This report summarizes in a broad and interesting manner the general methods of attack upon venereal disease used by this new governmental agency during the past year.

Industrial hygienists will find the section on *Educational Research and Development* particularly worth while since it indicates types of progress and methods of advance which should be directly applicable to industry. For example, the idea of making the physical examination a basis for the health education of the individual is beginning to find a firm basis in school and college hygiene, but as yet has little or no place in industrial preventive medicine.

The report contains a certain amount of statistical matter upon the control of venereal disease in the army and navy. Since much of this control has depended upon active measures resulting in the abolition of red light districts, the experience naturally applies very directly to industrial communities and the report thus furnishes valuable evidence of what can be accomplished through determined attack by competent agents.—C. K. Drinker.

A Clinical Picture of Anthrax. *John Randolph Graham.* New York City Dept. Health, Month. Bull., Nov., 1921, 11, No. 11, 284-286.—This is a description of the picture presented by the surface lesion caused by anthrax. The importance of prompt recognition of this disease, without waiting for verification by the bacteriologist, will be appreciated when it is realized that death may follow only forty-eight hours after the first sign of trouble, and that therefore the life of a patient depends upon early inoculation.—L. A. Shaw.

The Advantage of Serum Therapy as Shown by a Comparison of Various Methods of Treatment of Anthrax. *Joseph C. Regan.* Am. Jour. Med. Sc., Sept., 1921, 162, No. 3, 406-423.—The author reviews the various measures of therapy in use in the treatment of malignant pustule and quotes statistics showing the comparative mortality with different treatment. He discusses the various measures of local therapy in common use, pointing out the dangers that many of them possess, and concludes that:

"1. The measures of local therapy of anthrax in common use should be abandoned, owing to the disadvantages or even dangers they possess. . .

"2. The value, both prophylactic and curative, of anti-anthrax serum must now be regarded as established by statistics. . . . The mortality from malignant pustule will be reduced to a minimum by prompt recognition and early serum treatment.

"3. No case of anthrax septicemia should be considered beyond hope until intensive serum therapy has failed.

"4. The serum prepared by the Bureau of Animal Industry or according to their method has been proved of marked potency, being according to certain reports twice the strength of the European preparations.

"5. As originally described by the writer, the local injection of anthrax serum into the pustule is apparently the most effective means of local therapy and should always be used as a supplementary measure to the general administration of serum.

"6. Anthrax serum fulfills best the points requisite for an ideal method of treatment of anthrax: (1) It is appliable to all forms and locations of the disease; (2) yields on average the lowest mortality rate; (3) is a specific measure; (4) is a safeguard against generalization of the local disease if used in time; (5) offers the least amount of scarring and deformity; (6) causes a minimum of pain; (7) demands on an average the shortest absence from employment."—M. C. Shorley.

Normal Beef Serum in Treatment of Anthrax. *R. Kraus* and *P. Beltrami.* Abstracted as follows from Revista del Instituto Bacteriologico, March, 1921, 2, No. 6, 249, in Jour. Am. Med. Assn., Nov. 12, 1921, 77, No. 20, 1608.—"Kraus and Beltrami report additional experimental research which confirms, they say, the efficacy of normal beef serum in treatment of anthrax."—C. K. Drinker.

The Problem of the Tuberculous Employee in Industry. *Harry E. Mock* and *John D. Ellis.* Nat. Safety News, Nov., 1921, 4, No. 5, 17-19.—Pulmonary tuberculosis is the greatest of all occupational diseases. As industrial communities increased, living and working conditions became more congested; and tuberculosis mortality and morbidity reach their highest point in crowded and in-

sanitary quarters. It is true that primary tuberculous infection frequently occurs in childhood, but it is also true that overcrowded and insanitary living and working conditions are just as responsible for the spread of tuberculosis.

"The irrefutable argument for discovering and removing the tubercular employee from the working force lies in the fact that in those industries where an active fight against this disease has been made the tuberculosis rate has rapidly decreased."

In some industries the relationship of occupation to the development of tuberculosis is slight, while in others it is almost a causal factor. Dr. Collis attributes the production of the tuberculous employee to three basic influences: (1) insufficient food; (2) pathological fatigue; and (3) inadequate ventilation. All of these causes are as associated with the man's working conditions as with his living.

It is estimated that about 5,500,000 employees of both sexes, or "12.5 per cent. of the total wage-earning force of the country work under conditions where this atmospheric pollution is very prevalent and of known hazard to employees." Metallic dusts are probably most harmful. Specific industries in this group which show an exceptionally high mortality from lung diseases are cutlery and file making, metal grinding and polishing, brass working, printing, engraving, tool making and gold beating. Mineral dusts, vegetable dusts from cotton and linen textile mills, and from woodworking and paper making, and animal and mixed fiber dust, such as is found in hat making, all cause a high tuberculosis mortality rate.

Necessary measures for prevention among employees are:

"(*a*) elimination of the tuberculous from the working force;

"(*b*) protection of employees from predisposing causes;

"(*c*) supervision of the physical condition of the workers by medical examinations."

In combatting tuberculosis, ventilation, which includes dust removal, temperature, humidity, and cleanliness of working rooms, is the most important general condition for industry to consider. The salvaging of dust alone in some industries has paid for the installation of the system for dust removal.

The Pennsylvania and New Jersey Departments of Industry and Labor and the United States Department of Labor have published very good reports on the reduction of disease in certain hazardous occupations by the use of devices, and the education of employees to their use. State sanatoria are recommended for the use of tuberculous employees, and sickness insurance to provide for their dependents while they are undergoing treatment.—M. Dent.

The Effect of Nitrous Oxide, Natural Gas and Formaldehyde on Experimental Tuberculosis. *Jonathan B. Rogers.* Am. Rev. Tuberc., Oct., 1921, 5, No. 8, 637-642.—"Neither repeated nitrous oxide and oxygen anesthesia, nor formaldehyde nor natural gas influence the development or progress of the tubercle in guinea pigs infected through the respiratory route with a watery solution of tubercle bacilli positive sputum."—C. K. Drinker.

Tuberculosis of Husband and Wife. *Harry Lee Barnes.* Am. Rev. Tuberc., Oct., 1921, 5, No. 8, 670-673.—"1. The histories of 229 consecutive widowed patients admitted to the Rhode Island State Sanatorium, 1905 to 1921, show that 93, or 40 per cent., lost their consorts by death from tuberculosis, a tuberculosis mortality over three times that of the married people of the community.

"2. Immunity from many diseases is short lived and until much more convincing evidence of permanent immunity against tuberculosis conferred by childhood infections is forthcoming, a cautious logic will not accept the confident statements that are being made as to the impossibility or rarity of adult infection."—C. K. Drinker.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Matchbox Dermatitis. *M. Frei.* Abstracted as follows from Med. Klin., 1921, No. 16, in Arch. Dermat. and Syph., Dec., 1921, 4, No. 6, 830.—"Several cases of dermatitis were

seen at the Jadassohn Clinic, undoubtedly due to matchboxes. The lesions were in the pocket area, also on the hands and face. The causative factor was a phosphorous sulphur compound which was traced to one special factory. Investigation proved that owing to a shortage of amorphous phosphorus a substitute (phosphorsesquisulfid) had been used. A certain predisposition of the patient seems to be necessary. Similar cases have been seen in Sweden and Denmark."

FOLLICULITIS. Arch. Dermat. and Syph., Soc. Tr., Dec., 1921, 4, No. 6, 850.—"A blacksmith, aged 36, showed a folliculitis involving the beard, scalp, chest, abdomen and thighs. The eruption had recurred every summer, regardless of the kind of work he engaged in. Dr. Lane believed the condition to be due to sodium borate, which the patient used in welding. The freedom from perspiration explained the lack of symptoms in winter."

THE OCULAR FACTOR IN HEADACHE. *J. A. Kearney.* N. Y. Med. Jour., Nov. 16, 1921, 114, No. 10, 565-566.—The ocular factor in all forms of headache is far greater than is supposed, being probably not less than 10 per cent. Headaches due to eyestrain are invariably bilateral, and usually dull in character. Glasses are not always a sign that refraction error has been corrected; often they were prescribed long ago, or without the use of a mydriatic. "The site of the headache, when eyestrain is responsible, is often misleading as to the character of the existing error of refraction. In a general way, a frontal or supraorbital headache indicates hyperopic error; occipital, an imbalance of the extrinsic ocular muscles; and temporal, an astigmatic error."

Sometimes a patient suffers from headaches that seem to be caused by eyestrain, but upon examination no error of refraction can be found. "In a number of these cases, by turning the lids and carefully scrutinizing the conjunctiva, it may disclose changes from loss of lustre to decided disease."

"Not one of the routine determinations of the many that go to make up a complete eye examination should be omitted when a headache patient consults for relief, and if our best efforts are not sufficient to allay the distress entirely, advice should always be given the sufferers to seek for possible source elsewhere."—M. C. Shorley.

REPORT OF COMMITTEE ON LOCAL ANESTHETICS IN OPHTHALMIC WORK. Jour. Am. Med. Assn., Nov. 26, 1921, 77, No. 22, 1730-1735.—"In analyzing the results of this investigation, so far as our present knowledge of ophthalmic work is concerned, your committee feels justified in arriving at the following conclusions:

"1. For surface anesthesia, cocain in 4 per cent. solution, freshly made, possesses distinct advantages over all other local anesthetics, particularly for operative work.

"Concerning cocain anesthesia the following is offered:

"(*a*) In all instances, the anesthesia is equal to and in most cases it is greater than that produced by any other local anesthetic.

"(*b*) Its toxicity when used in the small dosage required for ocular anesthesia is almost negligible and does not count as a serious objection.

"(*c*) The desiccation and disturbance of nutrition of the cornea produced by it are negligible or entirely avoided if care is observed in keeping the eyelids closed after the instillations of the cocain solution and up to the time that the operative work is to begin.

"(*d*) The dilatation produced by the cocain is of short duration, does not often occasion inconvenience, and may be overcome promptly by the counter effect of a weak miotic.

"(*e*) The penetrating effect of cocain solution is increased by the addition of 0.5 per cent. solution of sodium bicarbonate.

"(*f*) The efficiency of cocain solution is not impaired by boiling.

"(*g*) The efficiency of cocain solutions is not affected either as to intensity or prolongation of anesthesia by the addition of epinephrin.

"(*h*) The use of stronger solutions than the one recommended are at the risk of seriously disturbing the nutrition of the cornea and interfering with the healing process.

"2. Phenacain in 2 per cent. solution stands next to cocain in efficiency.

"Concerning phenacain anesthesia the following is offered:

"(*a*) It has the advantage of producing a quicker effect than cocain and a slight antiseptic action.

"(*b*) It does not dilate the pupil, hence is valuable in producing surface anesthesia for tonometry, therapeusis and removal of foreign bodies from the cornea.

"(c) It does not produce desiccation of the cornea, nor, so far as known, disturb nutrition.

"(d) The solutions are not affected by boiling.

"(e) Epinephrin does not add to its efficiency in any way.

"(f) Alkalis should not be added to phenacain solutions as they cause precipitation.

"(g) Phenacain offers the distinct disadvantage of producing more or less irritation, which is very objectionable to sensitive patients.

"(h) Phenacain is incompatible with alkalis and their carbonate bases, and the use of glass vessels should be avoided in preparing the solution, porcelain being used instead.

"3. Procain (novocain) in 2 per cent. solution is the anesthetic of choice for infiltration anesthesia.

"(a) The addition of epinephrin does not increase efficiency, but does delay absorption and diminish the chances of accidental poisoning.

"(b) Procain (novocain) solutions should be injected slowly to aid in the avoidance of toxic effects.

"(c) The efficiency of procain (novocain) solutions is not increased by the addition of alkalis."—C. K. Drinker.

A New Test Card. *J. Monroe Thorington.* Am. Jour. Opth., Oct., 1921, 4, No. 10, 740-741.—On the test card here described and illustrated, Gothic letters are employed. With the exception of the two letters at the top, the rows of letters are numbered, the numerals being red to assist in detecting the most common variety of color blindness. By the use of these figures, the patient is enabled to indicate readily the number of the lowest row of letters which he can read, without having to count the lines.

There is a very gradual diminution in the size of the letters on the various lines from above downward, and all letters are constructed on the angle of four minutes. Care has been taken that a proper proportion of round, diagonal and square letters is maintained in each line and in each column. The letters B and S, so often confused, have been eliminated, as well as the letters R and K which have a marked resemblance to the letter A. G and Q have also been omitted since they are not good round letters.

Patients do not readily commit this test card to memory as they do the Snellen cards. The visual acuity in feet and metric distance is indicated by Roman letters and Arabic characters at the right of each line. Copies of this test card may be secured from Messrs. Wall and Ochs, 1716 Chestnut Street, Philadelphia. It may be had with red numerals and yellow letters on black, with red numerals and white letters on black, and with red numerals and black letters on white.—M. C. Shorley.

Foreign Body Spud Illuminator. *W. Holbrook Lowell.* Am. Jour. Ophth., Oct., 1921, 4, No. 10, 739.—This is a brief, illustrated description of an illuminator for foreign body spud or similar instrument, which has been devised by Dr. Lowell. "It consists of a fountain pen light with spring contact switch; to which is attached a smaller parallel barrel, equal in length, with a sliding member in this superimposed barrel. When the whole attachment is rotated on the fountain pen barrel, a tempered spring slides over the contact switch spring, thus giving a constant steady light. The spud is fastened in this sliding member. When pushed forward with the light on, the spud point and cornea are well illuminated and the light is where you want it when you want it, and the left hand is free to control the lids. The spud is protected when not in use by sliding it back into the barrel."—C. K. Drinker.

Late Traumatic Detachment of Retina Its Prophylaxis and Importance from a Disability Compensation Standpoint. *Harold Gifford.* Am. Jour. Ophth., Nov., 1921, 4, No. 11, 803-805.—"A large proportion of the detachments of early life, in unpredisposed eyes, are of the late traumatic class.

"As a matter of prophylaxis against such detachments, a period of as complete rest as possible (including binocular bandage) is desirable in the treatment of the eye.

"The possible occurrence of late detachment should always be provided for in settlements for damages, or disability compensation in cases of serious contusions of the eye. This applies with equal force to cases of deep perforating wounds with or without intraocular foreign bodies, or to accidents where the head or whole body has received severe shock."

Eye Findings in Brain Injuries. *Nelson M. Black.* Am. Jour. Ophth., Nov., 1921, 4, No. 11, 819-823.—This paper presents a summary of the ocular conditions likely to be found in connection with brain injuries, with some mention of other symptoms frequently associated with them.

"Examination of the eye grounds should always be a part of the routine of the examination of any case of head injury, and the determination of the visual fields when possible. When choked disc is found together with other symptoms of increased intracranial tension, operative interference is imperative. The relief of pressure in practically every instance prevents consecutive atrophy of the optic nerve when done in time. The finding of the symptoms of choked disc without other symptoms of intracranial pressure is not sufficient indication for operation, unless the intraocular manifestations are progressive in character; on the other hand, the absence of choked disc should in no wise preclude operative interference when other symptoms indicate its necessity."—M. C. Shorley.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Fatigue Study and Safety Work Co-ordinate. *Frank B. Gilbreth* and *Lillian M. Gilbreth.* Safety Engin., Oct., 1921, 42, No. 4, 167-169.—The problems of fatigue and safety could be conveniently analyzed through a fatigue survey, which would improve accident causing conditions as well as motion study conditions. The suggestion system, home reading box, museum and information bureau are activities which the writers believe are useful and can be used as "work in common" in safety and fatigue investigations. These can be supplemented and developed by a more scientific investigation if that seems necessary.—R. M. Thomson.

The Engineering Factor. *W. H. Forster.* Nat. Safety News, Dec., 1921, 4, No. 6, 13-14. —According to the author, real engineering capacity enables a man to attack a safety problem in the following manner:

"1. To see the basic hazard.

"2. To see the conditions producing this hazard, whether due to equipment, process or worker.

"3. To consider the pros and cons of the various methods of eliminating these conditions.

"4. To reach a wise conclusion as to the proper procedure.

"5. To present the case so that it goes through with the controlling powers.

"6. To organize to produce the desired result.

"7. To put the proposition through with the co-operation of all parties at interest."

But engineering capacity and correct engineering must go hand in hand with educational propaganda among the workmen.—M. Dent.

The Day of the Safety Engineer. *David S. Beyer.* Safety Engin., Nov., 1921, 42, No. 5, 227. This short article emphasizes the fact that a real safety engineer does not merely attend to mechanical safeguards, but analyzes accidents and tells what is needed to prevent them.—R. M. Thomson.

Accident Prevention and First Aid Work in the Telephone Field. *F. M. Downey.* Safety Engin., Oct., 1921, 42, No. 4, 170-173.

This is a discussion of the growth and achievements of the Bell Telephone Company's line force in accident prevention and first-aid work. The results obtained over a number of years are shown, and the vital importance of the hearty co-operation, support and interest of all parties, of competitive first-aid demonstrations, and of the publishing and distribution of bulletins is emphasized.—R. M. Thomson.

How We Licked the Goggle Problem in our Plant. *G. A. Kuechenmeister.* Nat. Safety News, Dec., 1921, 4, No. 6, 23-24.—This is the story of how the order for wearing goggles was successfully enforced in the plant of the Dominion Forge and Stamping Company, Ontario, Canada. It took a great deal of tact in dealing with recalcitrant subjects, and in one or two instances employees had to be dismissed, but the safety idea of goggles won out in the end. During the process of fitting

for goggles the company had an opportunity to persuade several men to go to the oculist and have their eyes examined, with the result that their goggle frames were fitted with special lenses, and their efficiency and dispositions were greatly bettered.—M. Dent.

Explosions Hazard and its Prevention. *Joseph F. Shadgen.* Abstracted as follows from Iron Age, 1921, Vol. 108, 127-130, in Chem. Abstr., Nov. 10, 1921, 15, No. 21, 3751. —"This is a thoughtful review of the literature on explosive mixtures of solids, liquids and gases, the characteristics of fuels being analyzed with special reference to powdered-coal installations and the means for prevention of explosions. Numerous tables, photographs of flame propagation and graphs are given."

Making Coal Mining a Safer Job. Safety Engin., Nov., 1921, 42, No. 5, 221-223.—A short review indicating that accident prevention work in the coal mining industry is showing results.—R. M. Thomson.

Coke-Oven Accidents in the United States during the Calendar Year 1920.—*William W. Adams.* U. S. Bur. Mines, Tech. Paper 293, July, 1921, pp. 32.—Accidents at coke ovens during 1920 caused the death of 49 and the injury of 3,415 employees. This represents a decrease of four fatalities and 616 injuries as compared with the record for 1919. The number of men employed during 1920, however, was 28,139, a decrease of 602, or 2 per cent. below the number employed in 1919.

Reducing the average number of men employed to its equivalent in 300-day workers, the fatality rate for 1920 was 1.64 per thousand men employed, and the injury rate was 114.13, as compared with 1.92 and 145.66, respectively, for 1919—a decrease in fatal accidents of 0.28 per thousand and in non-fatal injuries of 31.53 per thousand.

The chief causes of fatalities at all coke ovens during 1920 were, in the order of frequency, haulage equipment, burns, falls of persons, and falling objects. Non-fatal injuries resulted principally from burns, falls of persons, falling objects, haulage equipment and hand tools.

Tables are given showing the number and classification of injuries, 1916 to 1920; accidents in all coke ovens during 1920 by states, and by causes and by states; accidents in beehive and by-product coke ovens during 1920 classified by states, by causes and by states, and by character of disability; and number of widows and orphans caused by fatal accidents in all coke ovens, by states, during the years 1914-1920, inclusive.

At the end of the report two tables are included giving a summary of the fatality and injury rates for various branches of the mineral industry in the United States for all years for which comparable statistics for the country as a whole are available.—M. C. Shorley.

The Need of a Safety Code for Ladders. *F. A. Davidson.* Safety Engin., Oct., 1921, 42, No. 4, 180-182.—The author discusses the need of a National Safety Code for Ladders. A ladder code will help to reduce accidents through the focusing of public attention on the danger of using poor ladders, by educating the public as to what is a safe ladder, by serving as a guide to state local and insurance inspectors, and, finally, by the sanction of law in compelling safe conditions.—R. M. Thomson.

The Essentials of a National Safety Code for Ladders. *Clifford B. Connelley.* Safety Engin., Oct., 1921, 42, No. 4, 165-166. —The following essentials are suggested for ladder code making:

"1. Gathering and compiling information on ladders, including a historical statement of the development of the industry.

"2. Setting forth the specifications for construction of ladders of the various types.

"3. Suggesting rules for use, backed by authentic data in the form of discussions.

"4. Using abundant illustrations.

"5. Furnishing data on the properties and strengths of various woods.

"6. Describing ladder appliances.

"7. Pointing out safety methods and practices."

It is also suggested that the National Code for Ladders be in reality a textbook rather than a law book, an authoritative manual for making rules, and not a rule book.—R. M. Thomson.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Influence of Alcohol on the Function of the Heart. *G. Pantania.* Abstracted as follows from Arch. di fisiol., 1920, Vol. 18, 67, in Med. Sc., Dec., 1921, 5, No. 3, 257.—"The present research was undertaken because no definite conclusions appear to have as yet been reached in regard to the action of alcohol on the function of the heart. Some authors hold that it chiefly increases the cardiac activity; others again are of the opinion that its action is essentially depressive; and yet others think that very small doses act in an exciting manner while large ones have an opposite effect. Moreover, no one seems to have studied the action of alcohol on the excitability of the myocardium, to which the author has paid particular attention. In addition, he has investigated the effect of the excitation of the vagus and the contraction curve of the frog's heart. This was exposed and suspended to a lever according to Engelmann's method. After taking a normal tracing, varying quantities of ethyl alcohol diluted with Ringer's solution were injected into the frogs and other tracings taken at intervals of from 5 to 20 minutes. The results obtained, which are of general interest, have been summarized by the author approximately as follows: (1) Ethyl alcohol noticeably modifies the activity and functional properties of the heart. (2) This action manifests itself in a slackening of the heart's rhythm, which is chiefly due to a remarkable prolongation of the systolic phase when small doses are used, to a prolongation of the diastolic phase in the case of large ones. (3) The excitability of the myocardium is constantly increased by small doses of alcohol, but this fact is less and less apparent as the doses become larger, until excitability may even be diminished, with a corresponding elevation of its threshold. (4) The period of latency is constantly shortened by minimal doses of alcohol; somewhat larger ones do not appear to have always the same effect. (5) The length of the refractory period does not show any perceptible modification in the experimental conditions adopted by the author. (6) The excitability threshold of the vagus is increased by alcohol. (7) Under the influence of alcohol the heart stopped by means of a proper stimulation of the vagus re-starts its automatic activity more slowly than in normal conditions. (8) After stimulation of the vagus it takes a longer time for the automatic rhythm to become normal when alcohol is introduced into the organism than in the case of the same heart before undergoing intoxication."—M. C. Shorley.

The Effect of Cooling Power of the Atmosphere on Body Metabolism. *J. A. Campbell, D. Hargood-Ash,* and *L. Hill.* Abstracted as follows from Jour. Physiol., 1921, Vol. 55, 259-264, in Physiol. Abstr., Oct.-Nov., 1921, 6, Nos. 7 and 8, 440.—"Basal metabolism of the body cells is raised by cool out-of-door conditions, even when shivering does not occur; metabolism is controlled by cooling power, not by temperature. Formulae are given for rapid calculation of heat production of the resting subject, the information required being the dry kata-thermometer cooling power, the dry bulb air temperature, and the cheek temperature."—McKeen Cattell.

On the Carbon Excretion of Man in Wrestling and in Fencing. *R. Gullichsen* and *J. L. Soisalon-Soininen.* Abstracted as follows from Skandin. Arch. f. Physiol., 1921, Vol. 41, 188, in Med. Sc., Dec., 1921, 5, No. 3, 277.—"Observations on six persons in the respiration chamber on the energy liberated in fencing and in wrestling as measured by the carbon dioxide excretion. The results show that the muscular work involved in these exercises is of a very high order of magnitude when compared with other occupations involving heavy work."—M. C. Shorley.

Increase in Capacity for Work Due to Administration of Phosphate. *G. Embden, E. Grafe,* and *E. Schmitz.* Abstracted as follows from Ztschr. f. physiol. Chem., 1921, Vol. 113, 67, in Med. Sc., Dec., 1921, 5, No. 3, 278.—"Experiments on soldiers and miners showed that the administration of 7.5 gm. of sodium dihydrogen phosphate per day resulted in an increased capacity for muscular work, presumably by facilitating the resynthesis of 'lactacidogen'. A favorable effect on the nervous system is also claimed."—M. C. Shorley.

On the Size of the Heart, Blood Pressure and Pulse, before, during and after Short Periods of Heavy Physical Labor. *O. Bruns.* Abstracted as follows from München. med. Wchnschr., 1921, Vol. 68, 907-908, in Physiol. Abstr., Oct.-Nov., 1921, 6, Nos. 7 and 8, 427.—"Observations on the size of the heart as seen by X-ray illumination during short periods of heavy work. The author failed to get any appreciable increase in heart volume when the blood-pressure rose 30 or 40 mm.; he points out that this is in complete contrast to the results of animal experiments carried out by Starling and Straub. He considers that the discrepancy is due to the difficulty of standardising conditions when dealing with human subjects, and, moreover, amongst other things, to the inotropic influence of the sympathetic."—McKeen Cattell.

The Physiological Cost of Muscular Work: A Reply to Objections. *A. D. Waller* and *G. De Decker.* Brit. Med. Jour., Oct. 22, 1921, No. 3173, 627-630.—Waller's method consists in collecting the expired air for a period of thirty to sixty seconds during work and for one to two minutes during rest. By determining the percentage of carbon dioxide in the expired air, and knowing the volume of air expired during a given period, the carbon dioxide in cubic centimeters per minute may be calculated. With these data and by assuming a respiratory quotient of 0.85, the number of calories expended during a given amount of work is computed by referring to the tables of the calorific value of carbon dioxide for a given respiratory quotient, as determined by Zunst (*Pflüger's Archiv*, 1897, 68, p. 201). Later it was thought preferable to assume a respiratory quotient of 1.00 and calculate the calories accordingly. By this method an endeavor has been made to obtain a knowledge of the physiological cost of a variety of types of industrial work. Following a summary of the investigations by Waller and De Decker (*Brit. Med. Jour.*, May 7, 1921), Leonard Hill and J. A. Campbell (*Ibid.*, May 21, 1921) and J. B. Orr and J. P. Kinloch (*Ibid.*, July 9, 1921) published articles criticizing the validity of Waller's method. Waller and De Decker have replied to these objections in the present communication.

They answer the first objection, that the period (half a minute) during which the samples of expired air were taken was too short, as follows: They admit that longer periods were desirable but impracticable as a laborer could not be interrupted from work for any length of time. Furthermore, the minute-volume of expired air is increased during work and it would not be convenient to fit the subject with a bag to collect as much as 80 to 100 liters of air. Their present method permits the use of a bag of 20 to 30 liters' capacity. They have concluded by repeated trials that the error inherent in such short periods is much less serious than anticipated. To reduce the error further they calculate their results from the average of a series of periods.

In answer to the second criticism that they have failed to place sufficient emphasis on the influence of food on carbon dioxide elimination, Waller and De Decker state that they consider the increase in carbon dioxide output following food might amount to one-fifth of the resting value, but that this is negligible as compared to the more marked increase following muscular work. They believe this is justifiable considering the conclusion of Benedict and Murschausen "that the increment [of energy discharge] due to the work of forward progression was constant, irrespective of whether the subject was with or without food." Furthermore, the authors state that they were concerned with the carbon dioxide output of workers under their normal conditions of life.

The third objection to Waller's method is that the respiratory quotient has been neglected in determining the caloric equivalent of the volume of carbon dioxide exhaled. Waller and De Decker concede that this objection is fundamental and theoretically the most important of the three. They feel that the apparent inaccuracy of their method is compensated for by the ease with which a relatively large number of observations may be made and readily computed. They consider that their method is best adapted for use in the factory and on the road for the necessary preliminary survey on an extensive field. They conclude with Orr and Kinloch that at the beginning and end of exercise there might be a "washing out" or retention of carbon dioxide which would render a false respiratory quotient, but they consider this error eliminated by measuring the output only after a constant régime of work is established.

A fourth point of controversy relates to the interpretation of the observation that the carbon dioxide excretion, when determined at regular intervals during several hours' work, exhibits a progressive increase. This occurs even though the amount of work remains constant. Waller and De Decker object to the suggestion of Hill and Campbell that this increase is due to food and offer as a possible explanation that it is due to the decreasing efficiency of the laborer, though they feel that this point will require careful discussion after further investigation.—Cyrus C. Sturgis.

FATIGUE TESTS AT PURDUE UNIVERSITY. *G. H. Shepard.* Indust. Management, Nov., 1921, 62, No. 5, 281-286.—The main object of the tests reported here was to discover the minimum proportion of periods of rest to the total of working hours, by which workers on light-heavy muscular work can approximate their maximum output (light-heavy muscular work being defined as work in which the muscular system is continually under load during the operation, the load not being heavy enough to produce a sensation of muscular strain, but being repeated so many times that the worker becomes sensibly fatigued by the end of the day).

The experiments were made by a single operator, the work being performed on chest weights, the industrial day represented as closely as possible by a day of nine working hours during which one hour was allowed for lunch, between the fifth and sixth hours. Nine full days' work was done, varying the working period from twenty-five to sixty minutes, but allowing in each case a rest period of eight minutes. The forty-five-minute period was the most productive, increase of the work period from that point causing a steady decline in output, while shortening of the period also caused decrease, although not so uniformly. The thirty-five-minute period day was about as productive as the forty-five-minute period day, but between the thirty-minute period and the twenty-five-minute period there was a decided difference.

The conclusion is reached that a worker on light-heavy work and a nine-hour working day cannot give his maximum output unless he rests at least 15.1 per cent. of the time during working hours. But in order to be sure that rest periods will increase production the worker should have been interested by efficiency reward and other means to such an extent that he is seeking at all times to deliver his maximum output. It was further shown that the expenditure of energy as measured by loss of weight was greater (for 100,000 foot-pounds of work) when the forty-five-minute period was required than in the forty-minute period day. Therefore it is concluded that probably an industrial worker performing light-heavy work day after day will not maintain his maximum output unless he rests at least 16 2/3 per cent. of the time during working hours.

Further study of the data in regard to the forty-five-minute period day gives evidence that the total output of the day might have been increased by using a longer working period at the beginning of the day and gradually shortening it as the operator became fatigued.

Other problems remain to be solved, such as whether, by shortening the working day and thereby sacrificing the reduced output of the later hours, the output during earlier hours can be so increased as to give a greater output for the day; and, if so, what length of day would give the maximum output.

Two days of low temperature and high humidity show a falling off in output, which may be charged to the temperature, for it is not surprising that exposing the body of a worker to an excessive direct heat loss should produce a loss of output, just as steam-plant horsepower would be reduced by running with bare steam pipes.

In some preliminary tests the operator was allowed to work and rest as he wished. The average of four periods shows that the natural choice provided for 15.6 per cent. of rest; but whether this approximation to the proportion yielding the greatest efficiency is a general tendency or is merely peculiar to the operator tested remains to be determined.—G. E. Partridge.

THE PHYSIOLOGY OF FATIGUE. PHYSICO-CHEMICAL MANIFESTATIONS OF FATIGUE IN THE BLOOD. *Albert Baird Hastings.* U. S. Pub. Health Service, Pub. Health Bull. No. 117, 1921, pp. 42.—"1. Certain phases of muscular fatigue have been investigated with special attention to the gaseous and osmotic relationships in the blood of dogs.

"2. Hemolysis in vivo occurs in untrained dogs after severe exercise.

"3. The resistance of the red blood corpuscles to laking by hypotonic salt solutions is increased by exercise.

"4. The carbon dioxide content of the blood is decreased in both arterial and venous blood by exercise.

"5. The degree to which the hemoglobin is saturated with oxygen is increased in arterial and diminished in venous blood by exercise.

"6. These changes in gases result in a migration of acids, of which Cl′ is an example, into the plasma. A diminished osmotic pressure within the corpuscles results and is indicated by an increase in resistance to laking by hypotonic salt solutions.

"7. Certain of these changes are modified by long continued exercise. This failure in the efficiency of the processes of the organism is regarded as fatigue.

"8. The significance to the cardio-vascular and respiratory systems of the changes in the blood gases and the osmotic relationships is briefly considered."—C. K. Drinker.

Study of Movements. *L. Binet.* Abstracted as follows from Méd., Sept., 1921, 2, No. 12, 964, in Jour. Am. Med. Assn., Nov. 5, 1921, 77, No. 19, 1527.—"Binet describes the methods and findings with the ergograph and recording apparatus."

## WOMEN AND CHILDREN IN INDUSTRY

Women, a New Force in Industry. *Ida M. Tarbell.* Nat. Safety News, Nov., 1921, 4, No. 5, 13.—Miss Tarbell makes a plea to enlist the great body of women outside of industry in the safety movement. These women would work and work well, as evidenced by our experience with women's organizations during the war, and would be a great power behind the cause of industrial and public safety.—M. Dent.

Standards for the Employment of Women in Industry. U. S. Dept. Labor, Women's Bur., Bull. No. 3, Third Edition, Oct. 15, 1921, pp. 8.—This pamphlet presents, in revised form, the standards recommended by the Women's Bureau for the employment of women in industry. Standards are set forth for the regulation of: hours of labor; wages; working conditions, including comfort and sanitation, posture at work, safety, conditions needing reform and prohibited occupations; home work; and employment management. The federal government urges the industries of the country to co-operate with state and federal agencies in maintaining these standards as a vital part of the industrial program of the nation.—M. C. Shorley.

Women and Young Persons (Employment in Lead Processes). Statutory Rules and Orders, Nos. 1713, 1714 and 1715, London, Nov., 1921.—These three orders were prepared by the Home Secretary in pursuance of the Women and Young Persons Act, 1920: "*(a)* declaring what is a lead compound for the purposes of the Act, and prescribing the method of ascertaining whether any compound is a lead compound within the definition; *(b)* prescribing the periodic medical examination required under section 2 (1) *(b)* of the Act; and *(c)* prescribing the cloakroom, messroom and washing accommodation to be provided under section 2 (1)*(e)*." Paragraph 2 of Order No. 1714, prescribing the medical examinations, requires the employer to supply every woman and young person employed in any process to which the order applies with a health register in the approved form. Copies of this register (Form 616) and copies of the orders may be obtained from H. M. Stationery Office, Kingsway, London, W.C.2.—M. C. Shorley.

Child Labor. Analysis of Work Permits Issued during Biennium Ending June 30, 1920. State of Iowa, Bur. Labor Statis., Bull. No. 4, 1921, pp. 37.—According to the child labor laws of Iowa, a work permit must be issued for every child between the ages of 14 and 16 years wishing to obtain a position in certain specified industries, and no child under 14 can be employed under any circumstances in said industries. The laws within which the child may be employed as well as the total number of hours of labor in the week are defined by this law. A certificate from the superintendent of schools testifying to the educational standing of the child, a certificate from the medical inspector, and evidence of

the child's age are all requisites of the work permit. Thus the Iowa law provides for minimum age for entrance into certain industries; a certain minimum of education; a certain definite physical development; and good evidence of the child's age.

Statistics follow which "were secured from 7,469 work permits issued during the biennial period to 4,832 boys and 2,637 girls, and these have been tabulated and classified so as to show the number, by age, school grade, height and weight, for twenty-nine cities of the state besides a few towns combined into a miscellaneous group." A report of the United States Children's Bureau, December, 1919, has made child labor requirements somewhat more stringent than those provided by most of the states.—L. A. Shaw.

CHILD LABOR VERSUS CHILDREN'S WORK. *Raymond G. Fuller.* Am. Child, Nov., 1921, 3, No. 3, 281-286.—There is a wide belief that the child labor reform is predicated on the assumption that children should have no work whatever. This is far from the truth, but little has been done to establish children's work on a proper basis.

Psychologically, the basic characteristic of child labor is unmotivated activity, or activity motivated from without; and it is child labor in the school that is one of the main causes of child labor in industry and agriculture.

Children's work is activity that leaves plenty of time for schooling and play; is performed in suitable places; is favorable to development and health; is educational as a means of accumulating knowledge; and is a supervised activity, the supervision being in the interest of the child. Children have work impulses and needs as well as play impulses and needs, and they should have the discipline of proper work The school should help toward a more intelligent usefulness in the home.

Vocational training and part-time schools are recommended with too little thought about their development value; the vocational education of today is almost as far from meeting the needs of children as the older education was. Growth is the important consideration, and educationally the vocational curriculum has an advantage because it involves more action and deals with the concrete and the practical.—G. E. Partridge.

CONTROL OF THE EMPLOYMENT OF CHILDREN IN AGRICULTURE IN EUROPE. Internat. Labour Rev., Nov., 1921, 4, No. 2, 190-227.—There is but little direct legislation in Europe regulating the labor of children in agriculture but at the same time, and as if by common consent, most of the European states have tried, through the indirect method of education laws, to provide safeguards for children in the rural districts. On the other hand, there are labor laws which specifically exclude agriculture from the regulations affecting other industries.

There are a few laws applying definitely to the work of children in agriculture. In Switzerland, children may not be employed under the age of 12 in any agricultural undertaking other than that of their parents, and a limit is fixed of six hours' work a day during the whole period of compulsory school attendance and of two hours in the school term. In Denmark, children under 10 are unconditionally prohibited from working with machinery—and there are a few more such laws. In Great Britain and Ireland the labor of children in agriculture is more severely controlled. The Employment of Children Act, 1903, governs conditions for children in general employment, and its provisions were amended in 1918, by Section 13 of the Education Act (England and Wales). By this the employment of any child of "12 or upwards" is prohibited on Sundays; during school hours on any day when the school is open; and on any day before 6 o'clock in the morning or after 8 o'clock in the evening.

A system of rural inspection that would give the child in agriculture protection such as is provided by an efficient system of factory legislation has not yet been formulated. Exemptions from attendance at school complicate the whole question. Half-time or other partial exemption, exemption for seasonal work, the reduction of the school year for agricultural purposes in a given locality, all take part in depriving the country child of the protection which it is the aim of the best kind of educational legislation to give.

Data are given, in the form of tables, in regard to the ages between which every child must attend school unless exempted, the minimum period of compulsory school attendance, and the conditions under which absence from school may be allowed, as established in the countries of Europe.—G. E. Partridge.

The Adolescent and the Community. *E. L. Collis.* Welsh Outlook, Oct., 1921. *(Review by author.)*—In this paper it is pointed out that the adolescent costs the community considerable sums of money expended on health supervision and education. Nevertheless, there are no adequate channels through which he is passed on from school life to an occupation. This lack is due to the facts that education has too little regard for occupation, and that industry establishes too few occupational ladders. The result of this disregard for the adolescent is shown in an excessive tendency for youthful labor to wander from place to place endeavoring to find a round hole to fit into, which migration is a trying and wasteful proceeding, a social evil, and an economic loss. The wanderlust so acquired lasts throughout occupational life. The remedy is to be found in vocational guidance during education, and in vocational selection when new workers are engaged. In particular, committees are needed to stand between the schools and occupations, which should pay particular attention to promoting medical supervision in occupations, and to establishing cooperation between it and medical supervision in schools. Throughout the article statements made are supported by appeal to definite statistical data.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Sanitary Control in the Manufacture of Foods and its Economic Importance. *George Grindrod.* Am. Jour. Pub. Health, Oct., 1921, 11, No. 10, 920-922.—"Within recent years two fundamental changes have taken place in the production, preparation and handling of foods; these developments have had such effects on centralization of population, and dependence on manufactured foods as to make them of vital importance.

"The first development has been in the preservation of foods so as to permit their storage for indefinite periods and their transportation. This is essentially the dehydrating and canning industry.

"The second development has been in the transportation, purification and synthesis of foods. This is a natural though rapid outgrowth of the canning industry. The extensive production of foodstuffs from natural materials never before available for use as foods marks the beginning of an industrial development of inestimable extent."

The author cites the production of canned milk as an example of specialized sanitary control and of the application of bacteriology in the service of the public. He concludes by saying that "The development of scientific control of raw food materials, of the processing and the inspection of the finished product brought manufactured foods into the position where they are not regarded as substitutes for fresh foods, but as essentials."—M. C. Shorley.

Sanitation of Fruit and Vegetable Canneries. *Harry M. Miller.* Am. Jour. Pub. Health, Oct., 1921, 11, No. 10, 922-923.—The elimination of handwork by the invention of machines has done much to improve the sanitary conditions in fruit and vegetable canneries. "In general, every part of the fruit and vegetable canning industry has kept pace with the mechanical development so that today a large portion of our food supply is produced in modern sanitary buildings, provided with concrete floors, flooded with direct sunlight, the interior painted white, properly screened against the invasion of flies, bees and other insects, with adjoining grounds oiled or regularly sprinkled with water to keep down dust."

As in all problems of sanitation, the educational feature is the most vital factor to be considered as well as the most difficult to handle. The fruit and vegetable canning industry has made remarkable progress within the past few years and, with few exceptions, canners are fairly well versed in the consequences of running a plant under faulty sanitary conditions.—M. C. Shorley.

Monitor Ventilation. *Walter A. Griffin.* Boston Med. and Surg. Jour., Nov. 10, 1921, 185, No. 19, 572-574.—A report is given of two years' experience with the monitor system in the Sharon Sanitarium, where the results were satisfactory. The Canton, Massachusetts, school also uses this system and finds that it works well. It is urged that the monitor system can be used under a variety of conditions when numbers of people are congregated. The system has the disadvantage of requiring somewhat more coal and of being best suited to one-story structures, but these are not serious objections.—Barnett Cohen.

Ventilation, Weather, and the Common Cold. *George T. Palmer.* Jour. Lab. and Clin. Med., Oct., 1921, 7, No. 1, 39-52.—"From the results of this study there appears to be something inherent in the indirect method of ventilating schoolrooms by means of forced draught and gravity exhaust, as practised in this study, that is productive of respiratory affections, something which is not present in rooms ventilated with windows and gravity exhaust." Among these unfavorable elements are higher temperature, and uniformity of temperature and air flow. "In an unvarying atmosphere the occupants miss that pleasant stimulating effect. Evidently the absence of this quality affects health adversely as well as comfort.

"The temperature of window ventilated schoolrooms may be reduced as low as 59 degrees without increasing the prevalence of colds. . . .

"In spite of our inadequate knowledge of window ventilation at its best, the fact remains that the window rooms of this study, even though of crude arrangement and not built originally for the purpose, competed on favorable terms, from a hygienic and aesthetic standpoint, with the most elaborate and costly fan and duct equipment. . . .

"Natural ventilation has its limitations. That the schoolroom is not beyond these limitations is the indication of this study. . . .

"In its quantitative effect on respiratory illness school ventilation is of much less moment than the outdoor weather influence. Respiratory affections increase with the onset of cold weather. They diminish with the advent of mild weather in the spring. Wind and humidity accentuate the temperature influence. Sunlight exerts at least a warming influence sufficient to modify the unfavorable effect of cold. Abrupt changes in temperature do not influence respiratory illness as much as one might expect from everyday experience."—M. C. Shorley.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Do Workers Prefer to Pay? *M. F. Morrison.* Factory, Nov., 1921, 27, No. 5, 702.—An investigation of dental work in other plants convinced the officials of the New England branch of a large rubber concern that there would be a greater response from the employees if a charge were made for dental work. Free dental service impresses the employees with the fact that they are receiving charity from their employers, whereas they consider service from a plant doctor as having been necessitated by the industry and hence due them. In this plant the dentist may be consulted without charge and a toothache relieved without expense, but nominal charges are made for extractions, cleaning and filling, the lowest charge being 10 cents for cleaning and the highest, 75 cents for porcelain fillings. —M. Dent.

Cutler-Hammer Hospital. Hosp. Management, Oct., 1921, 12, No. 4, 60, 62.—"The medical department at the Cutler-Hammer Manufacturing Company is under the direction of the welfare manager and safety engineer. Its personnel consists of a doctor, a registered nurse and an orderly. The department is furnished with an automobile, enabling the nurse to visit employees' families where sickness is reported.

"Under an arrangement with a Milwaukee dental clinic, arrangements have been made for a dentist to visit the plant each day for an hour. Free dental inspections and treatments are thus provided for the employees."

The company feels repaid many times over for the expense of installing and operating its medical department by the material reduction in compensation costs which has been effected,

and by the goodwill which has been established among its employees. A brief report of the work of the department during 1920 is included.—M. C. Shorley.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

Physique of German Workers. Internat. Labour Rev., Nov., 1921, 4, No. 2, 144-146.—Tables are reproduced from an article by Meinighausen showing the height of workers in various occupations (in 1892), chest measurements, and weight (the lists of occupations given are all different). Comparison as to height shows that students, professors, etc., are the tallest, followed by engineers, while painters, plasterers and tailors appear at the end of the list. Millers, wheelwrights and blacksmiths have the greatest chest circumference (of the nine classes included); clerks, shopkeepers and bookbinders are at the bottom of the list. Brewers, cooks and butchers lead in weight, and painters, plasterers and bookbinders are last. Meinighausen does not accept as universally correct the view that men are influenced in their choice of occupation by their physical health and strength, and that strong youths have a preference for heavy work and the less robust choose lighter trades. Physique influences occupation to some extent, but occupation in turn affects physique very considerably. It is concluded that there are a larger number of physically robust workers in the country than in the towns.—G. E. Partridge.

## INDUSTRIAL PSYCHOLOGY AND INDUSTRIAL MANAGEMENT IN ITS HEALTH RELATIONS

Five Ways to Gain Better Co-operation. *E. K. Hall.* Factory, Dec., 1921, 27, No. 6, 804.—"Better industrial relations will prevail if the employee is given a definite status and a real interest in the business.

"1. Make it possible for employees to become stockholders.

"2. Teach employees the economics of business.

"3. Explain fully to employees the policy of the business.

"4. Make employees feel that they are a definite part of the business.

"5. Do not confine organization chart to officials of a business, but carry down to the janitor or the very last man in the organization."—M. Dent.

The Taylor System in Europe. Factory, Dec., 1921, 27, No. 6, 814.—"The July issue of *Technos* (Paris) reports two European views of the Taylor system. The first of these, taken from *Engineering*, says that the efforts to transplant the Taylor system from the United States to the United Kingdom have not been successful. The British worker is absolutely opposed to it, and one does not have to search long for the reason why. The reason lies first in the difference in working conditions between the two countries. A deeper reason is that, conceived by an engineer and spread by engineers, the system is so bound up in the mechanism of production that it sees in the human being only a machine; it does not account for the human elements in the problem; it cannot succeed generally or permanently in any civilized country. It is significant that even engineers are commencing to withdraw their support of the plan, as evidenced in a recent meeting at London.

"A second view of the Taylor methods of management, and one which comprehends a broader development of the system, is given by M. de Freminville. . . . This French executive believes that Taylor has crystallized for the first time, and after long and arduous research, the principles which should govern a scientific organization of work.

" 'Smooth out the difficulties before requiring any human effort' is M. de Freminville's interpretation of the fundamentals of the Taylor method. He believes the method is to guide the workman, collaborate in his work, help him to produce more, and at the same time assure him a good wage."—M. Dent.

Defects Affecting Fifteen Hundred Men. *B. Franklin Buzby.* Nation's Health,

Nov. 15, 1921, 3, No. 11, 612-616.—The work reported was done at the plants of the Keystone Leather Company and the Joseph Campbell Company, both in Camden, New Jersey. All the subjects examined were males and all received substantially the same examination.

The question is still open as to what means should be employed to improve the health of the worker. Is it to be force, persuasion, or suggestion? The first two methods should be discarded; the better method, as in private practice, is merely to tell the man the conditions found, enumerate the procedures that could be undertaken for relief, and then let him select his own method of treatment. It has been the rule in this series to tell every man of his exact physical condition in addition to making accurate notes upon it. For how else is the man to be made happy in a change of work unless he knows it is for his own benefit and is willing to co-operate? Again, in a general way, how shall applicants for work be treated, as compared to the employees already at work, when found to be defective? Every applicant for work rejected for disabilities should be told the cause of rejection and, in case the defect is remediable, he should be advised accordingly. If the defect is not remediable, the man is told just why he is a menace. The idea in physical examinations of new employees is that the employer can keep the unfit out of his plant until their defects are corrected and thus actually force health on applicants for work. The following major defects are herein briefly discussed: defective vision, diseased teeth and gums, nose and throat conditions, cardiac conditions, incidence of tuberculosis, surgical conditions, high blood pressure and disease of the kidneys.—L. A. Shaw.

OUR FALSE STANDARDS OF DISABILITY IN INDUSTRY. *W. Irving Clark.* Nation's Health, Oct. 15, 1921, 3, No. 10, 564-566.—Dr. Clark in this article first discusses the physical examination standards which were adopted in 1915 by the Conference Board of Physicians in Industry for use in industry, and gives figures, based on the study of a number of different industries, on the percentage of men rejected because of physical disability. The present tendency is to reduce the standards of rejection and to show that in every large factory men with almost any type of defect can be placed at work.

Dr. Clark goes on to discuss the experience with physical examinations in his own clinic, particularly in regard to defects which have frequently been overlooked hitherto and the importance of which is just beginning to be recognized. Using his own clinic experience as a basis, Dr. Clark feels warranted in drawing the following conclusions:

"Applicants having the following defects may be admitted to most factories without undue risk, provided they are selectively placed and watched:

"(a) Hernia of long duration which is complete or well held by a truss provided the applicant has done work similar to that for which he is hired for the four weeks preceding.

"(b) Varicose veins, provided ulcer and edema of ankles are absent.

"(c) Varicocele supported by suspensory.

"(d) Flat foot if without symptoms, that is pain in foot when applicant walks on toes. Pain in back on bending over.

"(e) Deafness, except in special departments.

"(f) Vision, depending on hazard and department.

"(g) Arteriosclerosis.

"(h) Endocarditis, unaccompanied by marked myocarditis.

"(i) Arrested tuberculosis—in special departments.

"Special search should be made for the detection of:

"(1) Arthritis of spine or sacroiliac region.

"(2) Arthritis of joints of long bones.

"(3) Old injury to bones entering into a joint.

"(4) Infected tonsils and those suggesting tendency to infection.

"(5) Potential hernia in southern Europeans of the stocky build who have protruding abdomens and have not been doing heavy work for three or more weeks preceding hiring. These men present a rather relaxed external ring and there is slight bulging along the inguinal canal on cough.

"From our experience we consider these five types of defect specially hazardous. They seem to figure largely in all industrial disability records."—Katherine R. Drinker.

## INDUSTRIAL SERVICE AND MUTUAL BENEFIT ASSOCIATIONS

An Association That Pays. *O. R. Barth.* Factory, Nov., 1921, 27, No. 5, 700-702.—The Westinghouse Electric and Manufacturing Company has a Victory Garden Association to which any employee of the company or person of the surrounding community is eligible to belong by paying dues of $1 a year. "Each person joining the Association is given a plot of ground to cultivate, and at the end of the season cash prizes are awarded for production, the most artistic garden and the best cultivation . . . Some of the members have canned quantities of vegetables while others have realized additional benefit in the way of a profit from the sale of their products on the market."—M. Dent.

A Shipyard Cafeteria. Nation's Health, Dec. 15, 1921, 3, No. 12, Adv. 30.—This article is a brief description of the cafeteria for employees of the Morse Dry Dock and Repair Company, at Brooklyn, N. Y., a ship repair yard with 4,000 workmen. The cafeteria which is conducted as a private enterprise under the direction of two women employees of the Morse Company, provides good, substantial, well-cooked food in immaculate surroundings and at a moderate price. Prompt service is a valuable feature of this restaurant, actual practice showing that 250 men can be easily and effectively cared for in twenty minutes.—Katherine R. Drinker.

## REHABILITATION OF DISABLED EMPLOYEES

Taking Care of the Industrial Cripple. *Lewis T. Bryant.* Safety Engin., Nov., 1921, 42, No. 5, 217-218.—This is a very brief description of how the Rehabilitation Commission of New Jersey is handling the subject of the industrial cripple. Through the co-ordination of the work of the commission with the activities of the compensation courts and the employment offices, industrial units have been established throughout the principal industrial portions of the state. Each unit has a very complete clinical equipment, rooms for compensation hearings and employment service.—R. M. Thomson.

The Influence of Physical Therapy in Reducing Disability Time in Fractures of the Long Bones. *Jonathan M. Wainwright.* Ann. Surg., Sept., 1921, 74, No. 3, 304-305.—The author presents a table showing the reduction of disability time in simple fractures among mine and railroad employees after the establishment of a physical therapy gymnasium at the Moses Taylor Hospital, Scranton, Pa. Each group comprised about 125 cases and the percentage improvement in disability time varied from 12 in fracture of the clavicle to 28 in fracture of the humerus.

"A study of this table gives very convincing mathematical evidence of the great economic value of physical therapy," the saving in time of disability for these cases representing about $4,000 to the employers annually. "The most important deduction to be made from this study is the great advantage, almost the necessity for the establishment of a physical therapy department in every large general hospital."—M. Dent.

# ABSTRACT OF THE LITERATURE

## OF

# INDUSTRIAL HYGIENE

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CONTENTS



## GENERAL

ANNUAL REPORT OF THE MEDICAL RESEARCH COUNCIL FOR 1920-1921. H. M. Stationery Office.—Any reader, after perusing this report, must be astounded to find that the extraordinary amount of work completed and in progress is being organized at a cost of only £130,000. Hardly one of the numerous problems of interest to the medical world is omitted; research is in progress relating to tuberculosis; cerebrospinal fever; influenza; pneumonia; rheumatic fever; dysentery; diphtheria; venereal diseases; problems of child life; rickets; accessory food factors; anoxemia; biochemistry and chemotherapy; radiotherapy; status lymphaticus; metazoan parasitology; and disorders of the cardiovascular, respiratory, excretory, and nervous systems. The Council controls all this work by appointing expert committees to supervise each branch of research. The services of university professors and the facilities which their laboratories afford are captured by comparatively small grants, while at the same time administrative expenses are kept at a minimum.

Our readers will be particularly interested in activities relating to industrial hygiene; here work is in progress, directed by committees, dealing with the incidence of phthisis in occupations, miners' nystagmus, industrial health statistics, physiology of muscular work, industrial physiology of the cardiovascular and respiratory systems, and industrial psychology, and finally work directed by the Industrial Fatigue Research Board. The pressing need for national economy in the spring of the year nearly brought the whole of this industrial work to a standstill; but a reorganization, with adoption of the Board as an integral part of the organization of the Medical Research Council, saved the situation.

A telling example of the value of industrial investigation in relation to disease is reported in the work of Dr. W. E. Gye, who had found from his experiments with Bacillus tetani that for true infection with multiplication of bacilli to take place, the local defence of the tissues must be broken down by some such agents as ionizable calcium salts or colloidal silica. The curious association of dust phthisis in industries with the inhalation of silica, completely established by Professor Collis, Dr. Haldane

and others, was then brought to his attention, and he has now found that, when tubercle bacilli and colloidal silica are together injected subcutaneously into animals which are normally unsusceptible to tuberculous infection, infection takes place, a local lesion being produced in which the bacilli grow rapidly. Hence it appears probable that the local defensive mechanism has been completely inhibited; later, the bacilli may become disseminated throughout the body and cause a generalized tuberculosis. The scientific interest of this work and its importance to metalliferous mining and other industries is hard to overestimate; moreover it is disclosing a possible relation between excretion of soluble silica by the urine and some of the forms of kidney disease so common in adult life.

Much work has been carried out with the kata-thermometer, devised by Dr. Leonard Hill. The instrument has been extensively used in factories and mills, in post office buildings, and in South African mines. Further, steps have been taken to standardize the instrument, to devise an electrically heated kata-thermometer and construct a recording instrument. Means are thus provided for readily measuring and standardizing movements of air, cooling power and evaporation, for workshops, factories, mines, cinemas, theatres, or other crowded places.

An interesting investigation by Prof. R. T. Leiper into the present position of hookworm infection in certain Cornish tin mines is referred to. The infection was still found to exist, and six men out of twenty-two at one mine were found infected, but the presence of other parasitic worms was also brought to light. Thus, among 130 persons examined 14.6 per cent. harbored Ascaris lumbricoides; 14.2 per cent., Trichocephalus; 2.3 per cent., Oxyuris vermicularis; and 5.4 per cent., Strongyloides intestinalis; while in twelve persons, *i.e.*, 9.2 per cent., were found the eggs of mites, a species of Glycyphagus which commonly occurs in wheat, cheese, and sugar. One species of Glycyphagus gives rise to various skin lesions, among which "grocers' itch" is the best known.—E. L. Collis.

The Sanction of the Eight-Hour Day. Bur. Research, Railway Employees' Dept., Am. Fed. Labor, Chicago, 1921, pp. 36.—The trend towards an eight-hour day in the United States and foreign countries is reviewed, followed by a discussion of the eight-hour day and output, the eight-hour day in relation to health and efficiency, and the social importance of the eight-hour day. The report concludes with general statements, recommendations, and decisions relative to the shorter workday.—M. Dent.

## POISONOUS HAZARDS AND THEIR EFFECTS: GASES, CHEMICALS, ETC.

The Treatment of Carbon Monoxide Poisoning. *R. R. Sayers* and *H. R. O'Brien.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2304, Dec., 1921.—The authors have found that, in spite of the common occurrence of carbon monoxide poisoning, there appears to be no uniformly recognized treatment for a person overcome by carbon monoxide. In the rescue work of the U. S. Bureau of Mines, however, a method has been developed which has been supported by laboratory investigation, and which has proved successful in practical experience, over a period of years. The method is outlined in this report, following a general description of the action of carbon monoxide and the symptoms of acute and chronic poisoning. The treatment is summarized as follows:

"1. Administer oxygen as *quickly* as *possible*, and in as pure a form as is obtainable, preferably from a cylinder of oxygen through an inhalator mask.

"2. Remove from atmosphere containing carbon monoxide.

"3. If breathing is feeble, at once start artificial respiration by the prone pressure method.

"4. Keep the victim flat, quiet and warm.

"5. Afterward give plenty of rest."—M. C. Shorley.

Aniline Poisoning. *J. Kawamura.* Abstracted as follows by Holtzmann from Wien. med. Wchnschr., 1921, No. 13, p. 597, in Hyg. Rundschau, Nov. 15, 1921, 31, No. 22, 701.—"We learn from this article chiefly that since

the War aniline colors, which were formerly imported from Germany, have been manufactured in Japan to a great extent. A not insignificant number of cases of poisoning (40) have occurred in this industry within the course of four years. The symptoms observed are the usual ones; treatment consisted in removal from the work, administration of a mild cathartic, venesection, lavage of the stomach, and oxygen inhalation. The author seems not to have had access to the most recent German literature on the subject."—M. C. Shorley.

## DUST HAZARDS AND THEIR EFFECTS

Dust Reduction by Wet Stopers. *D. Harrington.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2291, Nov., 1921.—Samples were taken from two mining districts in the western part of the United States in order to compare dust content in the air of mines using wet and dry methods of drilling both with and without external spraying. While methods of dust determination are not described, the figures show the air dustiness to be markedly less for the wet drilling than for the dry, although both exceed the permissible dustiness allowed by the South African standards. The author favors the elimination of dry drilling and the use of wet stopers because of greater speed, probably lower cost of operation, and a greatly reduced dust content in the air breathed by the miners.—Philip Drinker.

Annual Report of the Miners' Phthisis Board for the Period Ending March, 1920. Union of So. Africa, 1921.—Dr. Watkins-Pitchford, in the medical section of this report, adds a further chapter to the fascinating story of the fight which is being so ably waged to eliminate tuberculous silicosis from the gold mines of South Africa. He has been faced during the past two years with influences which make difficult the preparation of statistics comparable to those of preceding years. Thus, the return to the mines of many men who during the war joined the colors has been an important factor. Many of these men, who showed no signs of silicosis at the time they entered military service, on their return have been found during the interim to have passed into what is known as the primary stage. The deduction is drawn from such occurrences that there must exist a preliminary, latent and unrecognizable condition from which silicosis may evolve even though the individual be completely removed from risk of inhaling silica dust. Another influence affecting the statistics has been the recognition of a new group entitled the ante-primary stage, which is made up of men showing the earliest detectable specific physical signs of the disease. The recognition of this group, which leads not infrequently to elimination from employment, naturally reacts upon the next group known as the primary stage, and the yet further group known as the secondary stage. Several years must elapse before the records of the Miners' Phthisis Medical Bureau recover from the effect of these influences. Nevertheless, reviewing the position, Dr. Watkins-Pitchford considers that he may reasonably hold that the health of the whole body of miners has improved.

All men seeking employment in the mines have to pass a severe initial examination; since this examination was instituted in 1916, 3,592 men who have passed the doctors have obtained underground employment. The effect of this severe entrance examination is to be found in the statement that only two of this large number of men have, up to the present time, developed ordinary pulmonary tuberculosis, while no case of silicosis has developed among them. Silicosis, however, continues to make its appearance among those who have been employed for a longer time in the mines, but the length of employment previous to its appearance is steadily increasing, and the type of disease encountered is becoming for various reasons less severe. A claim has been made that coal dust has some influence in preventing the incidence of tuberculosis; this adds interest to the statement that no evidence is found that previous work in coal mines had any effect in retarding the development of silicosis. On the other hand, a curious phenomenon is reported; men who had previously been tin miners in Cornwall and so exposed to silica dust, when employed in the gold mines of South Africa, actually took

longer to develop silicosis than other new men, the mean length of time for the tin miners being eleven years and five months as contrasted with nine years and eight months for men coming from other forms of employment.

Dr. Watkins-Pitchford suggests that possibly the Cornish miner of today springs from a stock which has been subjected to risk for many generations, and so represents the survivor of a form of natural selection. Further evidence is given in support of the contention made in previous years that the onset of tuberculosis causes a condition of latent silicosis to become manifest.

Reference is made in the report to an investigation carried out in industries apart from the Reef, in which there is exposure to dust inhalation. This inquiry gives further support to the law that unless the dust in question contains silica, there is but little danger of pulmonary fibrosis developing, or of dust phthisis supervening. The case of the Bon Accord Quarry is of particular interest. Here the dust conditions could hardly be worse, but the rock dealt with, norite, was found to contain no free silica, and no definite case of silicosis was brought to light among men employed.—E. L. Collis.

# OCCUPATIONAL INFECTIOUS DISEASES: OCCURRENCE, TREATMENT AND PREVENTION

Contagion in Industrial Establishments. *D. L. Richardson.* Nation's Health, Jan. 15, 1922, 4, No. 1, 34.—This article summarizes briefly the measures which should be employed to detect contagious disease in industrial establishments and to prevent the spread of contagion from one employee to his fellow workers.

Among the various sanitary devices which aid in relieving the spread of contagious diseases are mentioned safe drinking water, drinking fountains or individual cups, adequate toilet facilities, suitably constructed lavatories, liquid soap, individual or paper towels, moisteners for stamps, envelopes, etc.

Ideally all employees should be examined for infectious disease before entering upon their duties, especially for tuberculosis and venereal disease. Cooks, waiters, bakers, and those who dispense drinks should all be licensed and examined by the health department at least twice a year. Widal and Wassermann should be done in suspicious cases; in some places Widal should be made on all persons applying for licenses.

An employee sick with an infectious disease should be excluded until he is well or until the physician thinks it safe for him to return to work. The factory doctor should inspect daily, during the period of incubation, employees who were in intimate contact with the sick individual.—Katherine R. Drinker.

The Local and General Serum Treatment of Cutaneous Anthrax. *Joseph C. Regan.* Jour. Am. Med. Assn., Dec. 17, 1921, 77, No. 25, 1944-1948.—"1. The measures of local therapy of malignant pustule that have been in common use for many years possess too many disadvantages to be considered locally effective. These disadvantages include pain, scarring, danger of introducing secondary infection into the lesion, liability of disseminating the infecting micro-organism both locally and into the circulation, prolongation of convalescence, lack of specific action, and high mortality rates.

"2. As anthrax in man is primarily a local infection with a decided tendency to remain as such in a high proportion of cases, no method of treatment is warranted which tends to break down the barrier zone of the inflammatory process which Nature has so carefully and characteristically constructed in this disease.

"3. Since we have available an extremely potent therapeutic agent in antianthrax serum, these measures should be omitted from the therapy of the disease. The serum should be administered both locally around the lesion and generally into the circulation by the subcutaneous, intramuscular or intravenous routes. The dosage, frequency of injection and route used necessarily depend on the location and severity of the lesions, the presence or absence of an anthrax septicemia and, to a lesser extent, on the degree of the constitutional symptoms. An outline of dosage in the various forms of the disease has been given above.

"4. The local injection of serum around the lesion every twelve to twenty-four hours

is a most desirable method to replace the local measures until lately in common use. It possesses none of the disadvantages or dangers of the previous methods. On the contrary, it is an additional safeguard against an anthrax septicemia, and appears to exert a very beneficial action in bringing about a rapid subsidence of the malignant pustule itself. The theoretical basis for the method is discussed in the preceding text.

"5. There have been eight cases of anthrax successfully treated in the last two years at the Kingston Avenue Hospital by the employment of Eichorn antianthrax serum, given by local injection around the lesion and general injection into the circulation, without any fatalities. The acute inflammation disappeared from the second to the sixth day of treatment, the eschar separated from the twelfth to the twenty-first day, and the wound healed from the twentieth to the thirty-second day. No sequels were noted in any instance, and the scar left was so minute as to pass unnoticed. The acute stage was over within a week."—C. K. Drinker.

## OCCUPATIONAL AFFECTIONS OF THE SKIN AND SPECIAL SENSES

Crude Coal Tar in Dermatology. *C. J. White.* Abstracted as follows from Arch. Dermat. and Syph., Dec., 1921, 4, No. 6, 796, in Jour. Am. Med. Assn., Dec. 17, 1921, 77, No. 25, 1997.—"White is impressed with the efficacy of crude coal tar in certain skin diseases. He uses 5 per cent. incorporated in zinc paste. His formula is as follows: Crude coal tar, 2; zinc oxid, 2; cornstarch, 16; petrolatum, 16. Mix thoroughly the cornstarch and the petrolatum; second, rub together the coal tar and the zinc oxid; third, combine the first product with the second. This method produces a nearly black, perfectly smooth paste, which smells strongly of coal gas and tar. These two injunctions are absolutely essential to success. Proper methods of application and removal of this paste are to be observed. Always cut all involved hair short when possible. Never bandage crude coal tar, pustulation is the result if this injunction is disobeyed. Smear on a medium coating of the paste with a wooden throat stick, and cover over the part with one thickness of old cotton or linen. Thin white cotton gloves may be advantageously substituted when we are treating the feet and ankles; and the footless legs of white cotton stockings may be drawn over the arms or legs of the patient. All of these dressings must be washed and boiled every twenty-four hours. The same crude coal tar should never be allowed to remain on the human skin for more than twelve hours. Every vestige of the previous application must be removed before making the next dressing and this may be accomplished by means of sterilized gauze, soaked in the oil of sweet almonds or in olive oil."—C. K. Drinker.

Anhidrosis Following Toxic Dermatitis. *W. Patzschke* and *R. Plaut.* Abstracted as follows from München. med. Wchnschr., Sept. 2, 1921, 68, No. 35, 1117, in Jour. Am. Med. Assn., Dec. 10, 1921, 77, No. 24, 1933.—"The toxic dermatitis developed after working on and wearing furs that had been treated with naphthalin. The functioning of the sweat glands was completely abolished thereafter, the young woman developing high fever at work, at the theater, and in dancing, and once she attempted suicide in her despair. This generalized anhidrosis was stationary for a year, and then daily treatment to stimulate the sweat glands was begun. After subcutaneous injection of 0.006, 0.003 or 0.001 gm. of pilocarpin, she was given an arc light bath for forty minutes. Under this combined treatment improvement was rapidly realized and has persisted to date. These minute doses of pilocarpin had no effect on the normal."—C. K. Drinker.

Care of the Eye Following Removal of Small Foreign Bodies from the Cornea. *William C. Bane.* Am. Jour. Ophth., Dec., 1921, 4, No. 12, 917-918.—The author emphasizes the importance of sealing the eye for twenty-four hours or more after the removal of a foreign body. His reasons for this measure are: (1) The corneal tissue normally does not have any blood vessels, but receives its nourishment by imbibition; (2) the closing of the eye prevents the admittance of infection through dust coming in contact with the open wound; and (3) by the application of a compress bandage, it is possible to reduce to a minimum the irritation and the discomfort

which would be caused by the movement of the eyelid.

Immediately after the removal of the foreign body it is Dr. Bane's practice to "apply some sterile vaseline in the palpebral aperture, then a small triangular pad of gauze with cotton between its layers, and adhesive strips retain the pad on the closed eyelids . . . The patient is advised to leave the pad undisturbed for twenty-four hours and to return for further attention if the eye is not comfortable. Otherwise the pad can be removed. If a second visit is made fluorescein is used to determine whether or not the healing is complete. As a rule the corneal wound is found healed. . . . After a corneal abrasion with loss of considerable of the epithelial layer, upon sealing the eye it is surprising how rapidly the destroyed epithelium is reformed."—M. C. Shorley.

Arsenical Conjunctivitis. *Milian.* Abstracted as follows from Paris méd., Oct. 15, 1921, 11, No. 42, 303, in Jour. Am. Med. Assn., Dec. 3, 1921, 77, No. 23, 1847.—"Milian called attention nearly ten years ago to congestion of the conjunctivae as a premonitory sign of poisoning from atoxyl, warning of impending blindness. He now generalizes this warning, saying that it applies to all arsenicals. The arsenic induces a paralytic vasodilatation. This may be the first and long the only symptom from the arsenic poisoning, but this arsenical conjunctivitis warns of danger and calls for longer postponing of the next injection of the arsenical. A little epinephrin morning and evening may be useful, but the main indication is to ward off microbian infection of the eyes, while this paralytic vasodilatation lasts."—C. K. Drinker.

## OCCURRENCE AND PREVENTION OF INDUSTRIAL ACCIDENTS

Occupation Hazard of Railway Shopmen. Bur. Research, Railway Employees' Dept., Am. Fed. Labor, Chicago, pp. 14.—According to the census of manufactures in 1914 there were 339,518 men employed in railroad repair shops. This occupation is extremely hazardous owing to the high accident risk to which the men are exposed. The report takes up the accident hazard as reported by the Interstate Commerce Commission, accidents to locomotive builders, the hazard as shown by the Workmen's Compensation rates in Pennsylvania, the mortality of shopmen, and finally the extent of their occupation. The data are presented chiefly in tables.—M. Dent.

Precautions to Be Observed in Entering Abandoned Exploratory Shafts and Pits. *B. O. Pickard.* U. S. Bur. Mines, Reports of Investigations, Serial No. 2295, Nov., 1921.—As a result of fatalities in abandoned exploratory shafts the author describes precautions which should be taken before entering shafts in order to be certain there is no poverty in oxygen. To poverty in oxygen the author attributes the greater part of such fatalities, and recommends that a little publicity be given to the subject of simple precautions.—Philip Drinker.

Safety amid Slaughter. *Louis Resnick.* Nat. Safety News, Dec., 1921, 4, No. 6, 7-12. 34.—This is a lurid description of the surroundings in the Chicago stock yards, with a reflection as to the difficulties of safety work in such environment. A trip through the yards reveals some striking examples of accident prevention work.

As an example the case of the "dope" room is cited. In this room the tops and bottoms of cans are prepared for soldering. The grooves of can covers are coated with a benzol composition. The fumes from this benzol were so heavy that operators and inspectors would fall asleep at their work, thus allowing many imperfect can tops to pass and at the same time exposing themselves to accidents. The superintendent devised an exhaust system which draws off these fumes and work can now go on as normally in this room as in other rooms of the factory.

Simple and convenient guards for almost every type of knife have been developed; illustrations of some of these are given in this article, and also descriptions of various types of accident guards that have been invented. —M. Dent.

Does Accident Prevention Pay? Why We Think It Does. *Ray H. Angove.* Nat. Safety News, Dec., 1921, 4, No. 6, 33-34.—A brief description of the safety department (including medical) of the Cutler-Hammer Manufacturing Company is given. Safety de-

vices were installed on machines which not only prevented accidents but also increased production, in one instance as much as 400 per cent. The statistics of the Cutler-Hammer Company are given for compensation and accidents for the years 1919 to 1921, and these prove conclusively that accident prevention pays. In 1919 compensation amounted to $1.55 per person, and in 1921 (first six months) to 53 cents per person.—M. Dent.

Twenty-Three Thousand Lives Saved by Safety Work in 1919. Nat. Safety News, Dec., 1921, 4, No. 6, 27.—This short paper gives charts showing the proportion of decrease in accidents from various causes for the years 1906 to 1919. Automobile accidents for that period have, however, increased from 0.4 to 9.4 per 100,000 of population.—M. Dent.

A Practical Viewpoint on Safety and Production. *John A. Oartel.* Nat. Safety News, Dec., 1921, 4, No. 6, 16.—Several instances are given in which accident prevention devices not only accomplished their direct purpose, but are also saving money for the companies and expediting the process.—M. Dent.

The Relation between Safety and Service Work. *Boyd Fisher.* Nat. Safety News, Dec., 1921, 4, No. 6, 17.—"Experts on health tell us that the so-called degenerative diseases, diseases of the heart, lungs, etc., which are not diseases so much as gradual impairment of those organs, are on the increase, and . . . we could prove much of the increase is due to conditions of work.

"So if we look not alone to safeguards and accident prevention, but look also to the question of fatigue, the question of industrial poisoning, the question of monotony and the question of plant hygiene, we are taking the legitimate next step in safety, which in many cases we have already taken. But we must not forget that, although accident compensation insurance does not extend necessarily to these gradual impairments, our moral responsibility is just the same towards those things as it has always been towards accidents." And also, "we should not be indifferent to the things in industry which contribute to the deterioration of the human mind."

## INDUSTRIAL SURGERY

Industrial Surgical Service: Past, Present, Future. *J. Rollin French.* Nation's Health, Dec. 15, 1921, 3, No. 12, 671-673.—This article is a plea for the more general use in industrial surgery of modern means of post-operative therapy for obtaining functional rehabilitation following industrial accidents. The author calls attention to the great value of practical exercise and training and of occupational therapy when selected with regard both to its usefulness in reestablishing functional ability and to its power to interest the patient and to stimulate him to co-operative effort in his own cure.—Katherine R. Drinker.

## INDUSTRIAL PHYSIOLOGY: NUTRITION, METABOLISM, FATIGUE, ETC.

Legal Requirements Regarding Seats in Industry. *Edith Hilles.* Nation's Health, Dec. 15, 1921, 3, No. 12, 659-661.—This article first reviews the legal requirements of the various foreign countries in regard to the provision of seats in work places, and then reviews briefly the laws in the United States. In 1920 forty-seven states had laws requiring seats in mercantile establishments, and thirty-six states required seats in both mercantile and manufacturing establishments. A few other states now require seats for women in practically all work places.

"The laws as they stand offer comparatively little protection to health, because even when a sufficient number of seats is provided, it is practically impossible to see that employees are allowed to use them. . . . Too often an understanding exists that if a girl is found sitting down she is liable to discharge. In some work places the old idea still holds,—that to be seated is to be lazy.

"The number of seats to be provided is in most cases designated as 'suitable,' though in a few states a proportion of at least one seat to every three employed women is required.

"The type of seat to be provided is usually left to the 'discretion' of the Industrial Commission or the inspectors."

Recent interest in industrial fatigue has brought the question of seating to the fore. "The reports of various committees studying fatigue, of the British Health of Munitions Workers' Committee, and the Federal as well as State Labor Departments, and of an infinite number of non-official groups dealing with industry, have all emphasized the importance of posture and seating at work. Their conclusions and recommendations are much alike in the standards suggested and, of course, go ahead of any legal requirements. Perhaps the best general summary of the points which they tend to bring out can be found in the Bulletin issued as a flier in an executive series of the National Safety Council, which reads as follows:

" 'The day of the ordinary wooden chair and of stools, without backs, as a part of modern factory equipment is past. Factory managers and the manufacturers of factory chairs know that a chair, to have utility, must be adjustable, so that it can be more nearly physiologically correct. During the last few years, the manufacturers of factory equipment have given some consideration to the things that make a factory chair desirable from the standpoint of physical comfort. Chairs should support the part of the body receiving the greatest strain from the work. The legs of the chair should be adjustable as to length, to suit the height of the user. A back rest which can be raised or lowered is generally desirable.

" 'For certain operations the factory chair must be high. Under such conditions a suitable foot rest should be provided. In most cases the foot rest should preferably be attached to the work table, rather than to the chair. It should be large enough, and placed in such a way that the operative may be seated in a normal position.

" 'When the work requires constant standing, chairs should be available for use during lulls in the day's work, and the employees should be encouraged to use them. Wherever possible, it is well to arrange the work so that the operator may stand part of the time and sit part of the time. Change of position appears to decrease fatigue and increase production.'

"The encouraging thing is not what has already been written into the existing laws and standards, but the fact that we have reached a time when shop equipment is recognized as needing study and needing standards, not only for the sake of economy and efficiency in production, but also for the sake of the workers who must be considered as human beings."
—Katherine R. Drinker.

## HAZARDS OF COMPRESSED AIR, DIMINISHED PRESSURE, GENERATION AND USE OF ELECTRICITY, AND ELECTRICAL WELDING

Compressed Air Machinery and Equipment. Nat. Safety Council, Safe Practices No. 47, Dec., 1921. Nat. Safety News, Dec. 1921, 4, No. 6, 43-50.—This pamphlet deals with the hazards from air compressors and air receivers; explosion hazards for the elimination of which it is recommended that special attention be given to compressor lubrication, cleanliness of the air at intake, air cylinder temperature, and cooling the air between stages and after compression; correct compressed air utilization, under which heading is included piping, portable air drills and reamers, and pneumatic hammers; and lastly, there is a section on general precautions, such as wearing goggles and the prevention of horse-play and practical joking.—M. Dent.

## WOMEN AND CHILDREN IN INDUSTRY

Child Employment and Adult Employment. Am. Child, Nov., 1921, 3, No. 3, 199-200. —The child labor situation registers the state of adult employment, but in part the effect is opposite to that which might be expected; children are being forced to go to work because older members of the family cannot find employment. The tendency is always,

when children become a part of the working population, for the children to lower the wages of adults and even displace adults, and it is partly because of this that the American Federation of Labor strongly opposes the employment of children under 16 years of age. Keeping children in school would not only help the labor market, but would benefit the children by giving them opportunity for further education.—G. E. Partridge.

ADMINISTRATION OF CHILD-LABOR LAWS. Part 4. EMPLOYMENT-CERTIFICATE SYSTEM, WISCONSIN. *Ethel E. Hanks.* U. S. Dept. Labor, Indust. Series No. 2, Part 4, Children's Bur. Pub. 85, Washington, 1921, pp. 159.
This is a very detailed study of the employment-certificate system of Wisconsin, treating administration, methods of securing permits, evidence of age, physical and educational requirements, vocation schools, the apprentice system and the enforcement of regulations. There is an appendix containing the laws of Wisconsin relating to employment certificates in effect April 1, 1918, the forms used in the administration of child labor laws, and the Orders and Resolutions of the Industrial Commission relating to the employment of children.

The pamphlet is summarized as follows: "The centralization in the state industrial commission of primary authority and responsibility over the administration of the child-labor laws gives that commission power to insure enforcement of existing legislation. The commission, moreover, through its authority to make rules and regulations, has unusual power to interpret this legislation. The laws themselves, however, are essentially weak in several particulars, notably in their failure to require school attendance of children between 16 and 17 years of age who must have permits and attend vocation school, in their low educational standard for going to work, and in their failure to require definitely a physical examination as a prerequisite to obtaining a permit. Moreover, because of failure of the industrial commission to exercise fully its supervisory powers, the laws are not uniformly enforced throughout the state. In part this failure is due to the fact that the attention of the commission has been given to the administration of other new legislation, especially the workmen's compensation and safety laws; in part it has been due to the practical impossibility of bringing about all at once adequate enforcement of all the changes recently made in the labor laws of the states; and in part it has been due to lack of funds for the large mass of work assigned to the commission.

"Two unique features of the Wisconsin plan of regulating child labor, not yet touched upon in the conclusions of this report, deserve special praise. The first is the system of vocational continuation schools, the most complete existing in any state in this country. These schools have become such an integral part of the regulations of child labor in Wisconsin that, though in their methods they are still frankly experimental, the desirability of their existence is no longer in question. The second is the apprenticeship system over which, as over the permit system, the industrial commission has absolute and complete control. Wisconsin is the only state in the Union which has created by law a modern apprenticeship system, and, though many difficulties have to be overcome, the ultimate idea of a combination of shop and vocational school training may prove the solution of the problem of adjusting young persons to useful places in the industrial system."—G. E. Partridge.

CHILD LABOR IN AGRICULTURE. *Gertrude H. Folks.* Am. Child, Nov., 1921, 3, No. 3, 267-273.—In seventeen states agriculture is specifically exempted from the provisions of the child labor law regulating the age at which children may work and the number of hours during which they may work. There are two reasons for this: It has been believed that employment in agriculture is not injurious to children, and that such work cannot readily be regulated.

Gathany, in 1920, made a study of farm conditions in the North Atlantic States, and has emphasized the necessity of eliminating rural child labor; and the Massachusetts Society for the Prevention of Cruelty to Children has reported that boys and girls from 10 years of age upwards are being employed in the tobacco fields of the Connecticut Valley under conditions which are injurious, boys working from nine and one-half to ten hours a day under canvas covering—an evil which was recognized as early as 1906 at a convention of tobacco growers in Kentucky.

An investigator of the National Child Labor Committee went through the agricultural section of Ohio in 1917, and, although comparatively few children were found employed in general farming or truck-gardening, "where found they were working for about ten hours a day, and were paid on the average $1 a day." Similar conditions were found on the onion and celery farms in Ohio and on the Pacific Coast where children are employed picking fruit, cotton and asparagus under bad conditions. "These are but a few instances of a situation that reaches from New England to the Pacific Coast, and everywhere is marked by overworked, under-educated children."

There are three types of farm work in which children are engaged: (1) that performed for parents at home; (2) that done for wages; (3) that which children perform with their parents but under contract. These must all be treated separately. Unless hours are excessive and the work injurious, the parent's right to permit or require his child to work at home cannot be interfered with, and children so engaged can be reached only indirectly through compulsory school attendance laws, and by the education of parents. But children employed for wages can be protected by direct legislation. They should be subjected to the same regulations as those which apply to other gainful occupations.

The third type of child labor is the most difficult to regulate. It has been suggested that families with children should not be employed in such work, but this is not easily made a matter of compulsion. Probably the best means is to make employers responsible for the observance of certain standards for the children of families hired by them under contract. The children should be permitted to work for only a limited number of hours a day, depending on age and physical condition, and the employer must be held responsible for observance of regulations, and for providing suitable quarters subject to the approval of the state department enforcing the child labor act.—G. E. Partridge.

Industrial Accidents to Young Wage-Earners. Am. Child, Nov., 1921, 3, No. 3, 200-203.—From two to three times as many children as adults, in proportion to the number employed, are killed or injured in industry. The accident rate in Southern cotton mills (although children are employed in the less hazardous occupations) was 48 per cent. higher for persons of 14 and 15 years than for those 16 years and over (1910). In a textile mill in Connecticut, during the year 1920, there were 37.1 accidents per hundred among workers under 15 years, and 42.9 for those between 15 and 20 years, while for all others the average was 21.6. Similar reports have been obtained in other places. Despite safety devices and safety campaigns, the high rate of injuries sustained by boys and girls as compared with older workers continues.

It has been suggested that the cause of this greater proneness to accident on the part of the young is to be found in carelessness, adventurous disposition, and the awkwardness of adolescence, but it does not follow that because accidents are due to carelessness they can be prevented. The only possible remedy is to keep children from working in occupations which may cause injury, until they are of an age when they can reasonably be expected to withstand fatigue and to take proper care. Thirty-five states now recognize the need of prohibiting employment in dangerous occupations to persons under 16 years, but the laws should be strengthened by specifying and increasing the list of occupations, and by raising the age at which children may be allowed to enter industry, or at least factory work.—G. E. Partridge.

Health Protection for Young Workers. *H. H. Mitchell.* Am. Child, Nov., 1921, 3, No. 3, 236-246.—This is the report of a health study made of 1,200 children working in various occupations in Newark and attending continuation school three hours per week. Case histories were carefully taken preceding the examination, the results of which, as regards vision and mouth conditions, are here recorded. Children having 20/30ths or better were regarded as normal. Of 616 boys, 60 had visual acuity of 20/40ths or less; and among 614 girls, 88 had visual acuity of 20/40ths or less.

Comparison with records of examination of vision made at the time of entrance into employment was possible in 127 defective cases, and it was found that 68.6 per cent. of the boys and 57 per cent. of the girls in that group had less visual acuity when examined the second time. The conclusion is reached that there is a distinct tendency for cases of defective vision at the time of entrance into

employment to grow worse. A large percentage of defective children were found who either did not own glasses, or did not wear them.

Relative to the condition of the teeth, similar results were obtained. "If an examination at the time of obtaining working papers is adequate protection to the health of the working child during the period of his employment, we should expect to find no dental defects in our examination among those cases that had had no defects when starting work." It was found that of 332 girls who were registered when obtaining working papers as having no defects, and who had worked six months or longer, 51 per cent. had dental defects at the time of the examination. Practically the same proportion of 281 boys were found defective. So far as dental conditions are concerned, therefore, these data indicate the inadequacy of the present Newark plan for health protection of working children and the need for continued health service.

It is shown also that, although the correction of dental defects at the time of going to work is of some value, periodic examinations are necessary in order to call the attention of the children to those defects which occur after beginning work, and to insure such corrections as may be necessary for their future general health. The condition might be remedied to some extent by stricter requirements for the correction of all defective teeth before granting work permits, but this would not cover the whole ground, as is obvious. There is reason for concluding that all children with serious dental caries in even one tooth should be treated either before they go to work or soon after. Those with tartar or beginning gingivitis should likewise have attention. Those having less serious conditions at the time of examination for working papers might be urged to have prompt dental treatment, and through follow-up work in the continuation schools compliance could be assured.—G. E. Partridge.

Seventeenth Annual Report of the National Child Labor Committee for the Fiscal Year Ending Sept. 30, 1921. *Owen R. Lovejoy.* Am. Child, Nov., 1921, 3, No. 3, 216-235.—Investigations of the field staff in regard to the conditions of child labor and the enforcement of the laws in West Virginia are reported briefly; also a survey of Alabama child welfare laws, a study of children's institutions in Kentucky, a similar study in Detroit, and a study of the health conditions among pupils in continuation schools in Newark. There is a brief summary of work done in procuring legislation, and of the new enactments in seventeen states. The publicity work of the committee is described. During 1921 this was confined mainly to "specialized publicity," such as following up the publication of reports, etc. Efforts were made to obtain the widest possible notice of Child Labor Day (the fourth Sunday in January), and two general announcements of it were sent out to about 1,500 newspapers. Four new pamphlets were published. A special department of information was organized. There are notes on natural conferences on child labor and on social work and on co-operation of the Committee with other agencies, such as the National Council of Rural Agencies and the United States Children's Bureau.

New measures are recommended: Twenty-one states are still below the standards of the Federal Tax Law; dangerous trade laws for children are in need of further study and revision; studies of the effect of child labor on health must be continued, with special attention to physical examinations; administration of child labor and child welfare laws must be intelligent and free from politics. It is stated that the field work for 1922 will be chiefly devoted to rural child life, with emphasis on education and recreation. The report closes with the financial statement for the year.—G. E. Partridge.

## INDUSTRIAL SANITATION: FACTORY CONSTRUCTION, ILLUMINATION, VENTILATION, HEATING, WATER SUPPLY, SEWAGE DISPOSAL

Oil-Camp Sanitation. *C. P. Bowie.* U. S. Bur. Mines, Tech. Paper 261, 1921, pp. 32.—"Although federal and state bureaus and individuals have written much on sanitation in rural districts in the United States, the author has repeatedly observed, during visits to min-

ing camps, oil fields (especially those of the 'boom' variety), fruit districts during the harvest season, and other places of temporary or semitemporary habitation, that the advice given by these writers is for the most part disregarded, and that much remains to be done in an educational way before the plane of sanitation in such districts becomes relatively as high as that in cities." The responsibility of betterment of insanitary conditions belongs to the states' governments but, though they all have adequate sanitation laws, they have inadequate enforcement of those laws.

The author takes up in detail the questions of the fly nuisance, mosquitoes, the location of camps, spacing of buildings, houses, water supply, disposal of garbage, stable refuse and sewage.

A bibliography of recent publications on camp sanitation and kindred subjects is appended.—M. Dent.

Bath House, Hospital and Heating Arrangements Provided for the Employees of the Lynch Mines in Kentucky. *Howard N. Evanson.* Abstracted as follows from Coal Age, Oct. 27, 1921, pp. 676-678, in The Digest, Nov.-Dec., 1921, 3, Nos. 11-12.—"Plans of the bath houses and the heating systems at the mines of the United States Coal and Coke Company are given in this article. The bath houses are located at the mine entrances and the lockers are suspended from the ceilings. The hangers are drawn by galvanized steel sash cord and rest under steel hoods attached to the ceiling. In this way, the clothes are kept out of the way and it is possible to utilize more floor space.

"A brief description of the hospital is given, but perhaps the heating plan is a more unusual feature. The buildings of this company are heated by hot water from a central heating plant. This water is conducted by pipes under ground. And in order to prevent corrosion, a special deactivating plant has been set up. This plant consists of a tank filled with loose thin steel sheets, upon which the oxygen acts, and a sand filter to remove any foreign material from the water."

Good Lighting Increases Production. *J. M. Hickerson.* Indust. Management, Dec., 1921, 62, No. 6, 325-328.—Adequate light has an important part in modern manufacturing, but it was the emergency of the late War that gave it its great opportunity. It has been shown that proper industrial lighting increases production with the same labor cost; increases the accuracy of workmanship; lessens the number of accidents; lessens eyestrain, and improves the morale of workers. An example is given of high intensity illumination installed in a Chicago factory making iron pulleys, by which there was effected a 20 per cent. increase of production at a cost amounting to 5.5 per cent. of the payroll.

Glare is light out of place. Its degree is determined by several factors: by the total candle-power emitted by the light source in the direction of the eye; by the distance from the light source to the eye; by the intrinsic brilliancy of the source; by the contrast in brightness between the light source and the working surface and surroundings; by nearness of the light source to the line of vision; by the total length of time during which the source of glare is present within the field of vision.

An investigation, made by a concern selling a lighting specialty, in which about 500 industrial plants in 157 towns and cities were visited, showed that while 25 per cent. of the work done in factories is under artificial light, only 17.5 per cent. of the manufactured goods are produced under artificial light; that 85 per cent. of the manufacturers are more or less satisfied with their present lighting, but only 40 per cent. of the plants are adequately lighted; that the lighting units are inefficiently spaced in 40.6 per cent. of the plants; that more plants are burning bare lamps than there are plants with lamps entirely equipped with reflectors; and that only 22.4 per cent. of the plants clean their lighting equipment regularly.—G. E. Partridge.

## INDUSTRIAL MEDICAL SERVICE: MEDICAL DISPENSARIES AND HOSPITALS IN INDUSTRIAL PLANTS

Partnership between Industrial Physician and Practitioner. *C. C. Burlingame.* Nat. Safety News, Dec., 1921, 4, No. 6, 39.—So long as the workman retains his right to choose the physician he wishes, it is to the interest of the industrial physician to form a partner-

ship with the community physician and make his problems community ones.

"To be a little more concrete, could we not assign to the industrial physician the duties of inspection of health hazards within the plant, the care of conditions arising out of or in the course of employment, studies into occupational research, the giving of first aid, medical, and surgical treatment, caring for the routine minor illnesses which would not ordinarily go to a doctor but the treatment of which would keep the employee on the job, and acting as a general clearing house to direct employees into the hands of other physicians and specialists? To this could not the industrial physician add the position of consultant with any physician who was caring for the employees of his concern?"

And, too, the private practitioner "owes it to his patients to know the etiology of the diseases which he may be called upon to treat, and without some knowledge of industrial conditions he is not in a position to pass upon the question of the etiology of all diseases."—M. Dent.

FIVE POINTS IN EMPLOYE HEALTH WORK. *Robert S. Quinby.* Hosp. Management, Nov., 1921, 12, No. 5, 60, 62, 64, 66.—The five points elaborated on in this article are as follows:

"Physical examination and necessary re-examination of applicants and those already employed.

"Dispensary treatment of sickness, accidental injuries, and in many cases dental, ocular, and other conditions.

"Supervision of factory sanitation and elimination of disease hazards.

"Home nursing and medical supervision of such cases as may seem advisable.

"Education in matters of health and personal hygiene."

A plant employing 900 or more persons should have one full-time physician, and an additional physician for each 1,500 workmen. The ratio of nurses to employees should be one to each 1,000. Dental defects comprise 40 per cent. of the total defects found in employees. A dental dispensary is, therefore, very important. Dr. Quinby believes that a necessary function of the industrial nurse is to raise the standards of home life of the workmen.—M. Dent.

RESULTS OF THE PHYSICAL EXAMINATION OF THE EMPLOYEES OF THE NEW YORK CITY DEPARTMENT OF HEALTH. *Maud Glasgow.* N. Y. City Dept. Health, Month. Bull., Nov., 1921, 11, No. 11, 269-284.—Since 1917 all employees entering the New York City Department of Health have been required to undergo a physical examination, the general character of which is herein outlined. The value of the examination is further enhanced by follow-up work. A special effort has been made to give hygienic instruction and advice when needed. Leaflets dealing with some of the more common sources of ill health have been used extensively. The necessary knowledge can be imparted to the patient without causing undue alarm, if judicious measures are employed.

It must be remembered that departures from the normal are not necessarily due to occupation; heredity, psychic conditions, home environment, including eating, ventilation, etc., must all be taken into consideration in assigning disabilities to their proper causes.

The disabilities which are most commonly met with are here mentioned, together with the benefits derived from advice and treatment in several specific instances.

The author is emphatic in his demand that equal opportunity and equal pay for equal work should obtain everywhere, and a square deal for everyone, regardless of sex. The greater morbidity found among women than among men is without doubt due to the fact that women are much oftener overworked and underpaid than men. Men receiving a low wage suffer in exactly the same way.—L. A. Shaw.

LIFE SAVING MAKES A POPULAR APPEAL. *Otto P. Geier.* Nation's Health, Dec. 15, 1921, 3, No. 12, 663-670.—This article is an account of the industrial physicians' exhibit at the Cincinnati Health Exposition—an exhibit which undertook to demonstrate "that medical supervision in industry is a vital factor in any health program, community or personal; that it is doing for the adult not only what medical supervision is doing for the school child, but that it is a great social and educational force for the employer, the employee, as well as engineering, medical, nursing, and dental professions."

An interesting feature of the exhibit was

the demonstration of two contrasting miniature workshops—one, dark, unclean, unhealthful and unsafe and in charge of a dissatisfied workman; the other, clean, well-lighted, well-ventilated, with machinery properly guarded and in charge of a contented and efficient workman. The men in the two shops greatly interested the visitors by their constant comments on the disadvantages and advantages of their respective working conditions.

The general plan of the exhibit was to give the public a composite view of industrial medicine as it is practised in the ten plants represented at the exposition "presenting the average conditions rather than the advanced work done in any one or more of the plants. It was interesting, for instance, to note that 11,800 physical examinations were made in all in 1920; that the average percentage of rejection was 5.7 per cent.; and that rejections varied from 1.2 per cent. to 8 per cent. It was impressive to note that among 11,800 employed, 70,000 medical cases and 35,000 surgical cases visited eight industrial dispensaries, making a total of 250,000 visits and revisits for all causes." During this same period, the out-patient department of the Cincinnati General Hospital afforded but 10,000 patients facilities for 30,000 visits.

Some of the industries "reported that as high as 7 per cent. of the working force daily sought the physician's aid for one reason or another. The average ratio of medical to surgical cases was as 7 to 3.5. The collected data showed, on the other hand, that almost invariably the sickness rate and absence because of sickness was materially reduced, in some instances being cut in half; that lost time from infected wounds after installation of medical service, with its prompt and proper treatment, reduced infection cases to the negligible point."

Statistics of this sort suggest that "industrial medicine is preventive medicine practised on the firing line; that the daily supervision, the accessibility of the service to the patient, the frequency of observation, the early diagnosis and prompt treatment is the sanest and most economical way of preventing human wastage; that it keeps the front line of industrial attack and maximum production intact; that this is the best means yet devised for keeping the old time 'evacuation stations' free from overflow of chronically incapacitated dependents; that to reduce the size of the human scrap heap most systematically we must move more of our scientifically trained medical men up to and on the industrial firing line."

The author goes on to discuss in some detail the value of industrial medical service as demonstrated in the health exhibit, not only to the worker in better working conditions, stability of health, and the reduction of suffering and loss from disease and accidents, but also to the employer in lessened absences from illness, higher output per man at a lower cost, and better morale of the working force.—Katherine R. Drinker.

HAS CLINIC FOR EMPLOYES' CHILDREN. Hosp. Management, Nov., 1921, 12, No. 5, 56, 58.—The Gilbert and Barker Manufacturing Company of Springfield, Mass., has maintained for several years an efficient medical department consisting of a physician and two industrial nurses. A thorough physical examination is given to every applicant for work, and, contrary to common belief, little objection has been made to this examination.

Employees are encouraged to come to the factory hospital for all slight ailments. Health and sanitation talks are given by the medical division and through the medium of the company's monthly magazine. A clinic for employees' children is kept up with great enthusiasm. "Sanitation as a foundation for better health is rigorously maintained" throughout the plant. Supplementing all these benefits the company provides athletic recreation and two types of financial assistance—"The Employes' Mutual Benefit Association" and "The Annuities and Benefits Plan."—M. Dent.

## INDUSTRIAL NURSING

A TALK ON HEALTH TALKS FOR INDUSTRIAL NURSES. *Anna Maybee Staebler*. Pub. Health Nurse, Dec., 1921, 13, No. 12, 647-648.—The following hints for health talks are given: the noon hour is usually necessary; select a quiet room; talk to not more than thirty-five persons at one time; begin promptly and stop in time; do not talk for more than fifteen

minutes; do not talk to mixed groups; if there are minors employed talk to them separately; emphasize only three or four important points at one talk; illustrate by posters; demonstrate when it is possible; have notices posted concerning the talks; and, finally, distribute leaflets at the close of the talk (these may be obtained free from federal and state departments of health).—M. Dent.

## INDUSTRIAL INVESTIGATIONS AND SURVEYS

The Hide, Hair, and Horsehair Industries. *D. Glibert.* Ministère belgique de l'Industrie, du Travail et du Ravitaillement, Service Médical du Travail, 1921. A. Lesigne, Brussels, 1921, pp. 448.—The 1921 report which Dr. Glibert, head of the medical department of industry, has presented to the Belgium government, is a valuable monograph of 448 pages. The inquiry therein described was restricted to seven trades connected with the manufacture and preparation of the skin and hair of animals. The slaughterer, the taxidermist and certain dyeing operations are outside the investigations.

According to a prearranged and uniform method, each of the 9,317 workers in the selected industries was personally examined by the medical inspector. The state of health of every individual was recorded under the heading of good, fair, or indifferent. The results obtained were summarized into elaborate tables. Further tables show under these same three divisions of health how each worker was influenced by place of residence (town, country, or mixed); by age at date of examination; by age at which he started work; by heredity as shown by the physical condition of the parents; and by the healthfulness or otherwise of the progeny of the employees. These figures worked out in percentages constituted the basis for comparative purposes. Under the same headings each department of each trade was analyzed in a similar manner, and compared with the above total figure. The trades reviewed are tanning, currying, unhairing, wool washing, pelt dyeing, felting and brush making. In some of the subbranches of these trades the number of employees is very small. This source of weakness for comparative statistics is pointed out by Dr. Glibert. He also notes that permanence in an occupation is largely influenced by the nature of the work, whether casual labor, or one requiring special aptitude and training. Unhairers constantly change, whereas tanners and curriers remain with the same firm for years. Matrimony and maternity largely restrict the industrial life of women.

The technical details of all the above industries are fully described, and special attention is drawn to any operation where injurious chemicals are likely to be handled; or where exposure to heat, strain, moisture, etc., may cause ill health.

The general average of well-being was poorer in those who had started in the tanyards between the ages of 12 and 14, than in those who had commenced their employment later, between the ages of 14 and 16. Among 1,760 tanners examined, 165 cases of dermatosis were discovered. The sore known as "pigeoneau," characteristic of this occupation, is fully described. Glibert associates it with the length of occupation, the arsenic and chrome used. He mentions that on one occasion where stronger solutions of arsenic had been employed, some portions were carried by the hands of the operatives to the penis, there causing excoriations. These sores led to the belief that the men suffered from venereal disease.

The health of leather curriers is below the general standard found in the combined industries covered by this inquiry. Of 838 leather dressers inspected, twenty-one showed affections of the skin. Unhairing, washing wool, dyeing, and preparing bristles for brushes, do not appear to be particularly inimical to soundness of body, whether these operations are done by hand, or by machinery. In the haircutting and plucking rooms conjunctivitis is very prevalent. Fifty-four cases were seen in men, and sixty-five in women. Septic sores on the fingers are common in some of these workrooms. Dr. Glibert draws attention to a slow spreading form of inflammation on the digits, which he has previously reported, peculiar to men who split rabbit skins. In one department, where the hairs are extracted by hand, the atmosphere becomes very unpleasant and impregnated with

dust and fluff. This work is regarded by the inspectors as being more disagreeable than injurious, as chest affections are not unduly common. Skin diseases, conjunctivitis, and ulcers of the mucous membrane of the nose are frequent. This work is done only by women. The constant use of the right forearm causes the muscles to hypertrophy and the tendons to thicken, and this is sometimes associated with neuralgic pains. The constrained position assumed, bending forward while sitting on the right-buttock for long consecutive periods, leads to spinal curvature. Seventeen instances of left lateral curvature were noted.

In the carrotting room nitrate of mercury is brushed over the hair either by hand or by machine. The ill effects of this salt are easily seen on the health of the men and women in this and the subsequent processes of brushing, stoving, finishing, etc. All the operatives look anemic, and the viability of the offspring of these workers is imperiled. The hands of the carrotters are always fissured and eczematous. Glibert does not think that the mercury is volatilized by any of the above operations, neither does he believe that it is absorbed through the skin. He suggests that it is sometimes carried to the mouth with food by soiled fingers; but the greatest risk is in the constant inhalation of bits of hair and particles of dust saturated with the salt. The type of mercurialism observed is chronic, and very rarely acute. The gums are swollen and ulcerated, salivation is unusual. The teeth are markedly blackened, and, as in saturnine poisoning, dark blotches occasionally appear on the inside of the lips. Dr. Glibert says that the mercury line is grayer and broader than that due to lead, but is easily mistaken for it. The nervous symptoms include tremors of the lips and tongue, and of the arms and legs on movement. The blood picture is but little altered from the normal. He regards chronic mercurial poisoning as much less grave than that caused by lead, since the evil effects disappear much more rapidly.

Between the years 1899 and 1920 only fifty-five cases of anthrax were reported: thirty-five among brush-makers, and sixteen among tanners. Sixty pages of the report are taken up with a general discussion on the subject of anthrax.

Improvements are being gradually introduced into the different trades in Belgium, as in other countries. In the tanneries, hand labor is being replaced by machines. By this means the chances of exposure to noxious agents are greatly lessened, the work is lightened, and the irritation from chrome, in the two bath method, is largely obviated. Local regulations have almost prohibited the use of sulphurous acid for bleaching fleeces, which was always attended with a certain amount of danger. Recent procedures are gradually decreasing the opportunity of absorbing poisonous doses of mercury. Though much has been done in this direction, Dr. Glibert more than hints that in the near future the salt of mercury will be found unnecessary. One excellent colored plate shows the effects of mercury on the teeth and lips, and others in black and white illustrate the volume.

This report will remain a useful source of information on these branches of industry for some time to come.—R. Prosser White.

# SUBJECT INDEX TO VOLUME III

This is a subject index to all the reading matter in the ABSTRACT OF THE LITERATURE OF INDUSTRIAL HYGIENE, and one should, therefore, look for the subject word. The name of the author follows the subject entry in parentheses.

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# AUTHOR INDEX TO VOLUME III